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VIDYA

August 1967

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MIDDLE INDO-ARYAN MISCELLANY*

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3. Ap. नालिअ, Sk. नालिक 'a fool'.[1]

The opening verse of the ग्रीष्मव्रज्या of the SRK. (verse 191) is as follows :

विश्लेषो जनितः प्रियैरपि जनैरुज्जृम्भितं नालिकैर्
मित्रेणापि खरायितं तरुणया दीर्घायितं तृष्णया ।
गुर्वी वल्लभता जडैरधिगता दोषाकरः सेव्यते
हा कालः किमयं कलिर्न हि न हि प्राप्तः स धर्मागमः ॥

It is a punning verse, and contains the trope Chekāpahnuti. The words are to be understood as applying ostensibly to the Kali-yuga, but really to the advent of summer. Ingalls translates उज्जृम्भितं नालिकैः as 'What things do not burst forth, my friend? (or, lotuses have blossomed).' As applying to the Kali-yuga, Ingalls understands नालिकैः as न आलि कैः. But the resulting sense is far from satisfactory. Any acceptable interpretation of नालिकैः should harmonize with the other unpleasant qualities enumerated in the verse: estrangement from the loved ones, roughness of friends, popularity of stupid persons, cultivation of vices, etc. The interpretation of नालिकैः offered in the SCP. violates this condition.

---

* Continued from *Vidya*, IX 2, August 1966, p. 5.

[1] For various reasons, a number of stanzas of Vidyākara's *Subhāṣitaratnakoṣa* (edited by Kosambi and Gokhale, HOS. 42, 1957—here abbreviated as SRK.) presents difficulties of interpretation. One obvious source of these difficulties is Prakritisms or dialectal expressions. The present effort to clear up a few of the obscurities is chiefly based on Middle Indo-Aryan materials and it is intended to supplement Ingalls' discussions in the Notes to his translation of the *Subhāṣitaratnakoṣa* (= *An Anthology of Sanskrit Court Poetry*, HOS. 44, 1965—here abbreviated as SCP).

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The fact is that नालिक here is a homonym. It means (1) 'a lotus', and (2) 'a fool'. In the latter meaning, it is the same as Apabhraṁśa नालिअ. Under *Siddhahema* 8, 4, 422 (15) Hemacandra has given नालिअ and वढ as substitutes for मूढ in Apabhraṁśa, and has cited the following illustrative verse:

जो पुण मणि जि खसप्फसिहूअउ
चिंतइ देइ न दम्मु न रूअउ ।
रइवसभमिरु करग्गुल्लालिउ
घरहिं जि कोंतु गुणइ सो नालिउ ॥

'He who ruffled by amorous feelings just keeps thinking and thinking without spending a *dramma* or a rupee, and who wanders hauntedly hither and thither is like a foolish fellow who goes on brandishing his lance just inside his home'.

Again *Deśīnāmamālā* 5, 9 gives नालिक (=मुग्ध, 'foolish') as the second meaning of the Deśya word तलसारिअ.

So उज्जृम्भितं नालिकैः means 'Fools have flourished (or, lotuses have blossomed).'

4. **Pk.** णिस्सह, णीसह, **Sk.** निःसह **'languid'.**

Verse No. 202 in the ग्रीष्मव्रज्या of the SRK. is a pen-picture of the water-buffalo in summer. The fourth line with Ingalls' translation is as under:

मग्नो वारिणि दूरनिःसहतया निद्रायते सैरिभः।

'.. with all annoyance gone, he [= the water buffalo] sleeps.'

In the Notes दूरनिःसहतया is similarly rendered as 'with annoyance far removed'. But निःसह here is the same as Pk. णिस्सह, णीसह 'languid', 'sluggish', 'weak'. Generally it refers to the limbs of the body or general physical condition. For example in the illustration cited under *Siddhahema* 8, 1, 93 (निस्सहाइं अंगाइं) it qualifies अंग. In *Līlāvai* 1101 णीसह qualifies वयण 'face' (The eloquent langour apparent on the face of a lady waking up is said to arouse jealousy of her cowives). Hāla's *Gāhākosa* (or *Gāthāsaptaśatī*) 1, 65 has णीसहेहिं अंगेहिं 'with languid limbs.'

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Monier Williams records it as occurring in the *Śiśupālavadha*, *Kathāsaritsāgara* and *Rājataraṅgiṇī*.

It is significant for the diction of the SRK. to note that some Des'ya lexicographers considered सेरिभ (with the meanings 'a carriage ox' and 'a buffalo') to be a Des'ya word.[1]

5. Pk. जलद्दा, Sk. जलार्द्रा 'a wet towel'.

SRK. 212 starts its list of summer refrigerants with the जलद्रs that are said to serve for an upper garment.

SCP. freely renders जलार्द्राः संघानं as 'A bodice soaked in cooling water.' Strictly speaking जलार्द्रा (fem.) means 'a wet cloth' (used as a garment etc.). It conventionally occurs among the cooling remedies in swoon or for allaying the burning caused by love-in-separation. See for example *Caupannamahāpurisacariya*, p. 213, 1·3; *Paumacariu* 15, 11, 7; 18, 5, 4 (here uncommonly neuter); 22, 5, 5; 26, 8, 7; *Svayambhūcchandas* 1, 72 (6); *Paumasiricariu* 2, 67. Monier Williams has recorded जलार्द्रा from the *Bālarāmāyaṇa* and the *Vikramāṅkadevacarita*, and जलार्द्रिका from the *Kādambarī*. Hemacandra's *Abhidhānacintāmaṇi* records जलार्द्रा in the sense of क्लिन्नवासस्. At *Śiśupālavadha* 1, 65 it has the specialized meaning 'a wet fan'.

6. Ap. झल (fem.), Sk. झला 'fierce heat'.

Ingalls translates वडवामुखानलझलाज्वाला (SRK. 232) as 'the glittering flame of underwater fire' (SCP. 232). On झला he remarks that it is unexampled and given by the native lexicons with the meaning 'sunlight', 'brilliance'.

It the form झल (later झळ) the word was current in Prakrit, Apabhraṁs'a and Old Gujarati–Rajasthani literatures. It occurs in S'īlāṅka's *Caupannamahāpurisacariya* (9th Cent.) on EI 12, 1·12: 'The rows of clouds allayed the burning that was caused by fierce heat' (कालंबिणीहिं समिओ झलसंतावो). Compounded as विरहज्झल

[1] See Hemacandra's *Deśīnāmamālā* 8, 44, commentary. *Gāthāsaptaśatī*, 2,72 uses सेरिह in the sense of a buffalo.

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(metrically it should be विरहझल) it occurs at *Saṁdeśarāsaka* (possibly 13th cent.) 137f:

उल्हवइ ण केणइ विरहज्झल...।

'None allays the fierce heat of separation.'[3]

As झळ, it occurs in st. 113 (थां दिस झळ रहियाह।) of the Old Rajasthani ballad *Ḍholā-Māru*. On the other hand in the Old Gujarati verse-tale *Mādhavānala-Kāmakandalā* composed by Gaṇapati in 1528 A.D., झल is used in a description of the mounting heat of the month of Vaiśākha: वैशाखइ झल वाधती (8, 35).

Hindi झल, झर means 'intense burning, flame'. For a few other NIA. derivatives see Turner's *A Comparative Dictionary of the Indo-Aryan Languages* (=IAL.), entry no. 5354.

These occurrences leave no doubt about the meaning of झल (झला). The meaning 'sun-heat' noted in Monier Williams on the basis of native lexicons comes fairly near to what we found from the actual usage. But 'brightness' is wide.

The झला with the meaning 'mirage' (मृगतृष्णा) recorded at *Deśīnāmamālā* 3, 53 seems to be a semantic development from the metaphorical meaning (दाह>तृष्णा).

7. Pk. Sk. कलमल 'aversion, loathing'.

The line कलमलोत्कलितं न तु मे मनः (SRK. 381) is translated by Ingalls as 'But my heart was never restless'. About कलमल, he remarks that it is a Prakritism and points to Hindi कलमल 'restless, trembling' in support.[4] The *Pāiasaddamahaṇṇavo* (=PSM.) gives 'pangs of love' and 'trembling, disgust' as the meanings of कलमल. The meaning 'disgust' fits better in the passage it cites.

---

[3] The rendering विरहाग्निज्वाला in the Sanskrit commentary seems to be based on the fancied derivation of झल from ज्वाला.

[4] Properly speaking Hindi कलमल as also किलबिल, कुलबुल means 'wriggling'.

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In Svayambhū's *Paumacariu* (9th Cent.), the word occurs in a passage (12, 12, 7-8) describing the state following frustration in love:

दससयगइहे वि विरहग्गि गुरु ।
पजलइ उप्पायइ कलमलउ, उण्हउ ण सुहाइ ण सीयलउ ।

'And Sahasragati's fire of viraha flared up. It produced in him an intense loathing—nothing cool or hot could comfort him.'

The gloss on कलमल at 36, 2, 6 in the Apabhraṁśa *Mahāpurāṇa* of Puṣpadanta (972 A.D.) explains it as ईर्ष्याजनितखेदः '(mental) depression born of jealousy'.

Accordingly the line from the SRK. can be precisely rendered as 'But my heart was never filled with restless aversion'.

उत्कलित literally means 'boiled', hence 'utterly restless'. Compare Pk. उक्कल्, Gujarati ઊકળવું 'to boil'. Compare the New Indo-Aryan materials under *Utkalati* (1716) in IAL.

8. Pk. Sk. झलज्झला 'sudden heaving', 'flush'.

In SRK. 532 (= Amaruśataka 12), the words of the young lady that delayed her love's departure are described as सबाष्पझलज्झल. Here झलज्झला is usually taken to mean 'the sound of falling drops'. Monier Williams records also another shade of meaning for the word, namely, 'the sound of flapping' (of elephant's ears, etc.).

In the *Caupannamahāpurisacariya*, झल्लज्झल् occurs twice as a verb. In both the places it signifies the heaving or throbbing caused in the cloud-mass by violent winds. Once the cloud-mass is compared to a drove of buffaloes driven by a cowherd girl (पिंडारवालियाइद्धं[5] झल्लज्झलेइ अहियं मेहउलं महिसवंदं व। p. 12, 1·14). Elsewhere the clouds are said to thunder due to the heaving arising from the oscillation caused by the wind (पवलंदोलणझल्लज्झलंतघणमुक्करव। p. 139, 1·17).

[5] The printed text (Prakrit Text Society Series No. 3) has पिंडारचालियाइद्धं. But obviously it should be corrected as पिंडारवालियाइद्धं.

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'Sudden heaving, flushing' seems to be the basic meaning of झलज्झल् (or झळज्झळ्). Associated with वाष्प, it probably signifies the tremulous flush of tears in the eyes, as we find in the Gujarati word झळझळियां (neut. pl.). Compare also Hindi झलझल 'shimmering', झलना 'to move a fan to and fro', etc., as given under IAL. 5351.

At SRK. 917 *b*, the rising moon is described as destroying darkness by means of the झलज्झला of the mass of light (ज्योत्स्ना-जालझलज्झलाभिरभितो लुम्पन्तमन्धं तमः ।). Here also the rising moon-light is conceived as some streaming liquid with flushing movements.

9. विङ्ख् 'to step, to walk'.

विङ्खन्ति क्रमदोलितोभयभुजम् (SRK. 522*b*) is translated as 'they should walk with successive swinging of each arm' (SCP. 522), and Ingalls considers the word विङ्खन्ति here suspect.

वीङ्ख 'to toss to and fro, to swing' is attested in the *Pañca-viṁs'a-Brāhmaṇa* (Monier Williams). Besides this वीङ्खा and वीखा in the sense of a particular mode of moving is recorded from some late works and lexicons. But Hemacandra's *Abhi-dhānacintāmaṇi* (st. 1500) notes वीङ्खा among the words meaning 'walking' (the other words of the group are गति, विहार, ईर्या, परिसर्प and परिक्रम).

Further Old Rajasthani has the word वीख (fem.) 'a foot step', 'a foot-print'. It occurs in the *Ḍholā-Māru* (st. 384, 498; diminutive वीखडिया at 366, 367). These occurrences authenticate विङ्खन्ति in the SRK. They also show that by about the tenth century वीङ्ख had developed the sense of walking.

10. Pk. गंज्, Sk. गञ्ज् 'to overpower, to subdue, to conquer'.

The word अगञ्जित in the phrase साम्राज्यमगञ्जितम् (SRK. 564 *b*) is understood by Ingalls in the sense of 'Uncontemned, unquestioned' on the basis of गञ्ज 'contempt'.

But गंज् is common in Late Prakrit and Apabhraṁs'a literatures in the sense of 'subdue, overpower, conquer'. Compare

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for example तग्गरिमगंजिओ इव 'as if overpowered by his greatness' (cited in the PSM. under गंजिअ) and अवरोप्पर जोअंताहं सामिउ गंजिउ जाहं 'whose master was overpowered even while they were looking at one another' (*Siddhahema* 8, 4, 409). Gujarati गांज्या जवुं 'to be overpowered, to yield' also preserves the original meaning to a degree. Hence साम्राज्यमगञ्जितम् would mean 'an unconquered or invincible kingdom'.

The meanings 'to disregard, to despise, to prove superior', etc. attached to गंज् are secondary.

11. Pk. अच्छोडिअ, अक्खोडिअ, Sk. आच्छोटित 'abraded, scraped, rubbed'.

In the forms आच्छोटित and आचोटित the word occurs four times in the SRK.

नखैराचोटिता पार्श्वयोः। (677*a*)
हलाग्रोत्कीर्णायां परिसरभुवि ग्रामचटका
लुठन्ति स्वच्छन्दं नखरशिखराच्छोटितमृदः। (1162 *ab*)
चरणाचोटितमुखाः। (scil. बकोटाः) (1185 *b*)
खुरपुटेनाचोटयन् भूतलम्। (scil. उक्षा) (1186 *b*)

Ingalls suggests the meaning 'struck' besides 'torn' given by Schmidt.

Prakrit अच्छोड् and its derivatives have two different meanings, viz. (1) 'dash', and (2) 'draw or pull with violent rubbing'. In the latter sense it is attested in st. 160 of the *Gāthāsaptaśatī* (अच्छोडिअवत्थद्धंतपत्थिए). The alternative form अक्खोड् seems to have mostly the second meaning, if we judge from the instances recorded in the PSM.

In the four passages cited above the meaning 'abraded, scraped forcefully' suits all the contexts. The first passage refers to the nail scratches on the sides; the second, to the sparrows scraping with their clawtips the soil in the furrows and rolling thereon; the third, to the herons rubbing their mouths against their feet; and the last, to the charging bull grazing the ground with his hoof.

For NIA. derivatives, see IAL. 1033 (*ākṣoṭayati).

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12. Pk. परिमलण, Sk. परिमलन 'rubbing all over'.

In the verse from S'riharṣa's *Ratnāvalī* (2, 12=SRK. 709), परिमलन is a Prakritism, having the same meaning as Sk. परिमर्दन. परिमलण and परिमिलअ occur respectively at *Gāthāsaptaśatī* 5,28 (परिमलणसुहा) and 7,37 (परिमलिआ गंवेण) besides elsewhere. मल्[6] is given as synonymous with मद् (=Sk. मृद्-मर्द्) in the Prakrit verb-list of the *Siddhahema* (8, 4, 126) and its numerous occurrences are noted in the PSM. Sk. परिमल 'fragrance' (lit. 'that which results from rubbing, crushing or trituration') has the same source as परिमलन.

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[6] For its NIA. derivatives see IAL. 9870 (*marati).

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EDUCATIONAL DEVELOPMENT AND MANPOWER PROBLEMS

[Address at the University School of Social Sciences, Gujarat University on 10th February 1967]

K. L. Joshi, M.A. (London)

Secretary, University Grants Commission
New Delhi

The definition of development is best given in terms of the document of the United Nations Development Decade Report where they have stated : " It should no longer be necessary to speak of economic and social development—since development as distinct from growth—should automatically include both. Development is growth plus change : change in turn is social and cultural as well as economic, and qualitative as well as quantitative." While this is not a new concept the emphasis is on change and also on active participation of human resources which should exploit physical resources for such a development. Secondly, it also means that development is brought about not by passivity dependent on the gift of nature or material capital and natural resources but by continuous and constant effort of trained human beings who work as agents of change for betterment of the nation in various spheres of activity. Change has thus to be worked for in a hard way fighting against natural drawbacks through employment of modern science and technology. Further, the implication is that if human resources are to bring about such a change of transformation, men and women should be properly trained and educated for the job and education and training attain a greater economic significance than hitherto attached.

Thus the economist is brought into the picture of educational development. This is a new development because education and training have an economic significance and trained human beings can add to production and induce and cause

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economic development. This new approach of economics of education during the last 15 years explained by such authorities as John Vaizy in his book "Economics of Education in 1962" and others like Prof. Schultz in his papers under the title "Economic Value of Education–1962" published by the Department of Economics, University of Chicago, and various UNESCO documents and the work of several other scholars like Prof. Harbinson, Halse, Floud, Bowman and Anderson and others indicate the new interest in the relationship of economic development and education.

It is not that the economists have shown interest in human resource development only recently but in the whole world today because of the classification of advanced, semi-advanced, partially developed and under-developed countries, the problem facing the under-developed and the under-privileged countries is what instruments and means can be employed by them in the shortest time possible to attain the goals of economic advance and social welfare; how far education and training of human resources would help in this process. Can we really analyse human resource development in economic terms? Are there other considerations also for education and other means of human development such as human rights irrespective of its contribution to production of useful goods and services? We always talk of education for citizenship—education for life adjustment and education for recognising the higher needs of man and for the sake of all the higher values of life—to raise the man to be able to think and appreciate good things of life. This we can call humanistic approach against the economic approach to human resource development.

Both these approaches are difficult to isolate as none of them completely would answer the aspirations of modern society. Besides both of them are inter-dependent. Without rapid economic growth educational development not only seems unrealistic but also goalless and without meaning. Only economic growth can create opportunities for the employment of well-trained

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talents of men and women developed by an ed[illegible] the a[illegible] system. On the other hand the humanistic approach is [illegible]ty c[illegible]y necessary for the fulfilment of the various desires of man for his independence and freedom of action. Therefore investments in education have to be in a large way productive but this perhaps means providing educational opportunities to all those who cannot be easily employed in the national structure where economic production dominates. The goal of rapid economic progress can be no doubt attained by the concept of education being productive. This means that education has to be completely co-related or oriented in such a way as to promote only economic production. The humanistic concept is based on the understanding of the social and cultural requirements of man which are promoted by education. Education is the concept of development of the whole man; not merely education in skills and training of working abilities but *education for knowledge and for the potential capacities of man for the fulfilment of social bonds.*

The *inter-dependence* of the two concepts can also be made clear. *Production of essential* goods and services must be increased on the one hand which on the other will contribute to the well-being of the man and to his appreciation of freedom and dignity of life.

Another problem that arises is the problem of economic resources for educational development which makes the two inter-dependent. A balance has to be established between educational development and economic development. One cannot outrace the other. If education progresses in such a way irrespective of the economic growth the result will be un-employment and frustration. If economic growth tends to be based on the use of illiterate labour force it will not only be lacking in social drive but also it will not help to grow at a fast rate for lack of scientific and technological knowledge and for *ignoring* research necessities *conducive to the very concept of economic growth.*

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Besides these social goals we *also mean* political and *economic contents*. The whole of political reorganisation with its democratic pattern cannot only be explained in terms of economic development but also in terms of the well organised educational structure which would prepare man to think and act freely and to appreciate each other's thoughts and ideas for the enrichment of life.

These ideas are rather peculiar to India and perhaps in some way there is no parallel to it. On the one hand we have been making vast investments through our plans for economic development including education and on the other hand the rate of growth of economy is a little halting with the result that there is the problem of the educated un-employed and many people have started asking questions what we are educating for particularly in the fields of secondary and higher education. The enrolment number of secondary education which was by 1960–61 of the order of 60 lakhs will double itself in a period of 7 years or so and the number for higher education which was only about 3½ lakhs by 1950–51 has already gone up to 15 lakhs in 1965–66, that is over a period of about 15 years this number has become more than four-fold and perhaps all of them are not being absorbed in the economic structure for jobs for which their education and training is meant to be suited. The question is, are education facilities being provided in such a way as to correspond with job opportunities generated by economic growth. The second question is that the rate of development of job opportunities is lower than the rate of growth of educational facilities particularly at the levels of secondary and higher education.

This problem has perhaps no definite answer. However, the Education Commission Report, by its objective has *intended to prepare a programme of transformation of the education system so as to relate it to life, needs and aspirations* of the nation and to prepare a programme of expansion of educational facilities particularly on the basis of *manpower needs* and with an *accent on equalisation of educational opportunities*, emphasised on the

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qualitative improvement of education so that ... the standards achieved are adequate and kept continually rising in quality and at least in a few sectors become internationally comparable.

We can ask the question how far the Education Commission have tried to envisage this problem and suggest any remedies. To seek an answer will also be difficult because in the important Chapter V on 'Enrolments and Manpower' which deals with enrolment policies at different stages of education and a *forecast of manpower needs there is an attempt to relate manpower estimates to enrolment.* But the Commission do not come to any definite conclusions or make recommendations or policy statements which would help us to clarify the problem. Actually there is in the Commission's Report a Minute of Supplementation by one of the members of the Commission on this very problem entitled 'Manpower, Planned Development and Reform of Higher Education' which perhaps analyses the problem but which has not been considered an integral part of the report for the obvious reason that the computation involved in arriving at conclusions was perhaps based on assumptions which would not be consistent with the assumptions on which the other Chapters of the Commission's Report are based.

The Minute of Supplementation to the Education Commission Report by Shri R. A. Gopalaswami has perhaps analysed the problem in a succinct way and it is hoped that readers of the Education Commission Report when they study this question in Chapter V turn to this Minute to understand the nature of this problem which as pointed out earlier has no historical parallel. The Minute of Supplementation states: "It is well known that our efforts to realise a planned economy within the framework of a free, democratic and quasifederal policy is a pioneering venture. It is wholly unprecedented in history. In every aspect of this effort we come up against the difficulty that there is no ready-made model to follow. We are obliged to find our own way by trial and error. The main point of the Minute of Supplementation seems to be that the

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time [illegible] ved when the rate of growth of institutional capacity [illegible] to be moderated instead of being further accelerated. A change of tempo is needed also in order to efficiently plan and implement reforms which are necessary for solving the problem of qualitative shortages which has come now to the fore-front." The illustration given is of engineering education. "*Engineering education* is one branch of higher education where it is indubitable that the planned rate of growth has to be the fastest. Even in respect of this branch the studies made in the Institute of Applied Manpower Research have led to the conclusion that the present tendency to go on accelerating the rate of *growth is mistaken* and should be corrected." To quote again from the Minute of Supplementation it is stated that it "deals fully with this wider question and gives reasons for believing that our current rate of accelerating growth of higher education (taken as a whole, inclusive of all branches) is outrunning the growing capacity of our National Economy to employ the growing numbers of higher education manpower efficiently. It is also outrunning the growing capacity to allocate the resources needed for maintaining and raising the quality and utility of higher education." It further states that "We are in fact going through a process of *educational inflation* which requires to be brought under control for much the same reasons as the other and more familiar processes of inflation in the national economy."

The remedy suggested is to fix a ceiling for the over-all rate of growth of higher education including all its branches. There has to be a decision as the starting point for subsequent determination of appropriately different and consequently unequal rates of growth for different branches of higher education so as to correlate such unequal rates to the unequal rates of growth of different occupational groups of higher educated manpower which will be dictated by the changing pattern of employment in the National Economy.

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It will be seen that the main difficulty of t rty ca ducation Commission and of the author of the Minute of Supplementation was the *conflict* between the *ideal* and the *actual*. Ideally the Commission said the programmes of expansion of educational facilities on the basis of manpower needs and transformation of the educational system were to be related to life needs and aspiration of the nation. This is an *undoubted ideal* which is obtained in developed countries and no developing country could ignore it. But the *actual picture* in the Minute of Supplementation has been given in terms of *controlled machinery* or what is called the problem of *educational inflation* because the word *manpower* has been used here in the abstract sense referring generally to the *human capacity to perform useful work of any kind*. And the term has been used as a collective name for an *aggregate of human beings who possess* such capacity. It is explained that the word "manpower" very often means "labour force" but the labour force applies more to the industrially developed countries. It says: "In conditions of our country it is convenient to use the word manpower to mean not only the labour force but also housewives. This is so because experience has shown that it is very difficult to draw the line which separates those rural housewives who participate in the labour force from those who do not. Statistics of the labour force and the derivation of so-called participation rates which are based on such dividing lines are apt to prove misleading." Computation is made for all persons of the age group 16–59 with the exception of such of them as are enrolled as pupils in the educational institutions. The main facts that go to the concept of the insidious educational inflation are the figures of educated employment seekers. The conclusion was that by the year 1960–61 in the field of higher education the national stock of the educationally classified persons was 82·9 lakhs. For a nation of nearly 44 crores of population for the year this was not a very big stock and yet this included too many educated employment seekers. Among these were 67 lakhs secondary educated and only about 15 lakhs higher educated. Deducting the number of students enrolment

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in educational institutions from this figure which comes to about 15 lakhs it has been computed that there would be about 67 lakhs who were available for employment constituting the notional stock of educationally classified manpower. Out of this there were 14 lakhs of higher educated manpower and 53 lakhs of secondary educated manpower. It has been further computed that about 10 lakhs out of 67 lakhs could be left out as they were engaged in Farm house employment. The remaining figure of 57 lakhs can be analysed into a figure of 10 lakhs of educated employment seekers and 47 lakhs of educationally classified manpower in organised industrial and service employment. This proportion is according to the author disquieting.

However, taking into consideration a perspective frame-work of plan for the year 1975–76 it has been pointed out in the note: "We have seen already that the number of employment seekers in 1960–61 was 10 lakhs that was already too high and was recognised as a social problem. We see now that while the number settled in employment increases from under 58 lakhs to 170 (three times) the number of employment seekers increases (six times) from under 10 lakhs to 59 lakhs. The proportion of employment seekers to employed persons increases from about $\frac{1}{6}$th to $\frac{1}{3}$rd. It was also computed that whereas in 1960–61 employment seekers had an average waiting period of 92 weeks this will be increased to 137 weeks in 1975–76."

The picture given above seems to be a little cynical and also appears to be pessimistic and arguable. The Minute of Supplementation also discusses some of the possible objections such as (*i*) incomplete and defective statistical data, (*ii*) pessimistic assumptions about the growth of economy and the relationship between the growth of employment and growth of economy, (*iii*) the computation does not take into consideration shortages in certain sectors, and (*iv*) lastly even if there is surplus of higher educated and secondary educated manpower there is need for such a number in society or in the category known as farming and household industry. These

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objections have been answered by the author, the ai[illegible]rty ca[illegible]ing that in the first place statistics cannot be perfected *in vacuo*. They need to be processed and studied purposefully and used in order to apply to policies and plans. Whatever figures are available have to be used and further improved upon. In regard to the rate of growth of economy the pessimistic picture is based only on the present trends. The third objection is based on certain information tabulated in the report and indicates that it is difficult to get away from the fact that identification or accuracy of shortages cannot be easily done. The fourth objection is answered by the fact that the social problem is not exaggerated while there is no doubt whatever that the economy can be benefitted by a substantial increase in the number of educationally classified persons employed in farms and homes. To realise such benefits the educational curricula has to be adapted to secure the results and in the present system this cannot be easily acquired.

The above arguments are illustrative of the *complex nature* of the problem and the need for an unbiased and scientific way to deal with it in which the economist and the statistician would be of great help. The way in which this problem has been set out in the main body of the Education Commission's Report in Chapter V is slightly different from this rather turse analysis. Commission's approach is idealistic and humanistic. Their argument is somewhat like this, that India is a big democracy and democratic and *socialistic societies* emphasise mass education and equalisation *of educational opportunities*. Human resources therefore have to be best deployed to secure the most beneficial form of educational development. The basic principles guiding their thinking are as follows:

(*i*) Effectual general education of not less than 7 years' duration to every child on a free and compulsory basis and also expansion of lower secondary education on as large a scale as possible.

(*ii*) Provision of higher secondary and university education

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training and qualified persons consistent with the demands for trained manpower and the need to maintain essential standards.

(*iii*) Emphasis on development of professional, technical and vocational education to prepare skilled personnel for the development of agriculture and industry.

(*iv*) To liquidate mass illiteracy as only a literate democracy can fulfil its social objectives.

(*v*) To eliminate social inequalities.

The Commission thus has given a different slant to the problem by describing it as the problem of enrolments and manpower and they have based the forecast of manpower needs on the study undertaken by the Planning Unit of the Indian Statistical Institute, New Delhi, and the Unit for Economic and Statistical Studies on Higher Education, London School of Economics, in collaboration with the perspective Planning Division of the Planning Commission. The ISI/ISE estimates are detailed and offer estimates upto 1986 on the assumption of a higher economic target. The position in 1961 according to them was that there were 52 lakhs of workers with qualifications equivalent to matriculation and above, ⅔rd of whom were in towns and employed in Public Administration, Education and other services. About 10 lakhs were graduates and they were concentrated in service occupations. Only about a lakh were in manufacturing industries.

The forecast for 1976 and 1986 is very interesting. The assumption is that there will be over-all growth of 6·6 per cent a year from 1961 to 1976 and 7 per cent in the whole period 1961 to 1986. Within these targets for certain sectors like factory establishments the progress is 11·85 per cent and 3·86 per cent in agriculture. The idea is that even if agriculture will produce more with the use of modern scientific and technological methods the personnel employed in agriculture will not be very much. It has been estimated that in 1976 those workers

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who are matriculates and above would increase, the ai[illegible] lakhs and in 1986 to 326 lakhs. Graduate workers [illegible]rty ca[illegible] increase from 11 lakhs in 1961 to 33 lakhs in 1976 and 65 [illegible]khs in 1986.

Thus it will be seen that this approach emphasises increasing number of educated people to go into the 'pipe line' of employment in varied occupations and even new occupations generated by the expanding economy. It has been estimated that the annual output of matriculates will grow from 6 lakhs in 1961 to 48 lakhs in 1986 and that of graduates from 1 lakh to 8 lakhs. The percentage of each age-group who matriculate should rise from 7 per cent to 27 per cent and those of graduates from 1·5 per cent to nearly 5 per cent. The needs for graduates in engineering, medicine and agriculture and teaching will naturally be more and the whole problem of enrolments has been taken on a most optimistic scale in relation to population and in relation to social desire for higher education as well as professional and vocational education.

At the same time the Education Commission who have accepted the forecast of ISI/ISE as against the approach of the Minute of Supplementation have come to the following conclusions in regard to future educational development:

(*i*) To restrict the unplanned and uncontrolled expansion of general, secondary and higher education if massive uneducated unemployment is to be avoided.

(*ii*) To make special intensive efforts, to vocationalise secondary education and to develop professional education at the university stage.

(*iii*) To devise suitable machinery at both the national and state levels which will relate the estimates of manpower needs effectively to the out-put of the educational system so that by and large there is some assurance that a suitably trained person would be available for every job to be done and every educated person would find a job appropriate for his education and professional training.

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In this context the Commission have also stated that development of [illegible] education should be based on about 50 per cent of the school leavers after the 10th class and in the 11th and 12th class whether these classes are with the schools or junior colleges or in the normal three-year colleges as pre-university classes (This is a liberal interpretation of what they mean) There will be diversification of courses in relation to different vocations. The Commission also say that they generally agree with the note on Supplementation of the Report by Shri R. A. Gopalaswamy and they considered that in order to pursue the policy 4 objectives stated by him should really form the basis of future policy in respect of manpower planning and enrolments :

(*i*) The annual requirements in relation to higher educated manpower should be assessed in advance and annual supply of such personnel should be made available by the higher educational institutions.

(*ii*) It should be ensured that higher educated manpower will not remain unemployed or wastefully under-employed.

(*iii*) Courses of studies in higher education should be reviewed in the light of changes which are occurring in the pattern of employment.

(*iv*) A new type of promotional extension courses of study for secondary educated persons who are already in employment and are found suitable for promotion should be developed so as to raise their educational level.

However, these principles are perhaps not enough and detailed study of this problem will be necessary if the idealistic approach of the Commission is to be reconciled with the realistic analysis in the note of Supplementation. The following comments however might be useful :

One of the most important educational reforms is to have a uniform pattern of education in all the States of

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the country so far as the structure is con[illegible], the ai[illegible]he Education Commission have devoted Chapter [illegible]rty cars problem but have come to the conclusion which wil[illegible]ed [illegible]haps mean a bit of a halting attitude. They have recommended a system of education of 10+2+3 or (4+3+3+2+3) of which 2 should be with the school system. They have said as follows :—

(*i*) Structure and duration play a significant role in improving standards.

(*ii*) The changes proposed in the structure and duration are rather slow in making an impact on quality because their full implementation has been spread over 20 years.

(*iii*) The most serious weakness of the existing educational system lies not in structure but in its feebleness. We are getting relatively much less than what we should from the system as it exists and the resources that go into it in the organisation of structure for addition of time can remedy this basic weakness.

It will be seen that today there is a confusion of the class structure for lack of uniformity from State to State. This has been made clear in the Charts at pages 26 and 27 as well as page 37 of the Commission's report. The problem of educational system, structure and standards has been before the nation for many years right up from the time when the Sadler Commission Report in 1919 made a recommendation of a 12+3 system of education. Sargeant Report in 1944 however suggested a 11+3 system that is higher secondary plus 3-year degree course. University Education Commission of 1947 suggested a 12+3 system. Secondary Education Commission suggested a 11 or 12+3 system, which created confusion and the Sampurnanand Committee Report on Emotional Integration in 1962 suggested a 10+2+3 system the 2 being provided either in an intermediate college or a junior college. On these lines actually junior col-

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leges established in Karala. But today the nomenclature in this full of confusion and difficult to evaluate in terms of migrat students or in terms of the needs of employers. There are high schools, higher secondary schools, pre-university classes, intermediate classes, junior colleges in Kerala, 5-year engineering degree courses, 4-year engineering courses, 3-year engineering courses some after intermediate and pre-engineering courses and pre-medical courses. There is also a confusion about B.A., B.Sc. pass and General and Honours courses. The only uniform practice is in regard to M.A., M.Sc. or M.Com.

What Education Commission have recommended has therefore to be of immediate significance if educational structure of one State broadly has not to differ from that of the other State. Every State can have as much scope of experimentation and innovation in regard to teachers, curriculum, prescription of courses and books, medium of instruction, norms of pupil-teacher ratio, etc. The national system of education like in the U.S.A. or U.S.S.R. or Canada or Australia has the basic assumption of uniform structure in all the States. For example, in the U.S.A. it is 12+4 system, the 12 being obtained as 8+4 or 6+6. In the U.S.S.R. there is a 5-year university education system after 10 years of schooling; in the U.K. it is after the fifth form which is attained at the age of 16 i.e. after about 10 to 11 classes that a student has to spend 2 or 3 years but majority spend 3 years in the sixth form for securing advance level courses and the admission to universities is possible after a student has secured advance level in three subjects and ordinary level at least in two. Thus a student in the U.K. joins the university at the age of 19.

The main point about a 2-year buffer course between the high school and university education in the form of intermediate or junior college course whether these are with the schools or colleges is that during this period a large number of students could be diversified after a good foundation of general education of 10 years to various vocational courses. The Education

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Commission have intended that 50 per cent sharty can verted to vocational courses like those in polytechnicied witcultural polytechnics, industrial trade schools, teachers training institutions for elementary teachers and hundreds of short-term and part-time courses for different types of occupations that could be introduced about this time in institutions known as junior colleges, as obtained in the U.S.A. Actually our 1300 training schools for primary teachers are like junior colleges, so are the polytechnics and the proposed agricultural polytechnics recommended by the Education Commission.

Once this sector is properly defined and identified good many difficulties in regard to nomenclature and computation of numbers in the system of education and training required for producing manpower would be solved.

The next question is the economic analysis of education in terms of the impact of education upon the quantity and quality of educational skills, labour, etc. This has to be examined at the time of *manpower computation*. The level of initiative and inventiveness of population has to be raised through the educational process. In this case the demand for education may have to be divided into education for production purpose and that for consumption. The latter means really using education for the enjoyment of fruits of living as against education to earn a living. This raises important points which go with the approach of the Education Commission.

Whenever the question of manpower is analysed into depth it will be found that it is easy to compute requirements of engineers, technicians, craftsmen, teachers, doctors, agricultural experts, etc., but requirements for occupations which are not firm or non-professional like the requirements of liberal professionals of lawyers, economists, physicists, etc., cannot be easily computed. Moreover, national resources we are spending for *compulsory* education or education upto the age of 14 have also to be considered in relation to general education for social

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purposes [illegible]stion which the economist or the hard boiled planner [illegible]raise is whether a country should make universal literacy in [illegible]llowing educational development of this type a ***sine qua non*** of its development programme. Even if the nation is able to do this it would reduce overall level of living and delay overall development in the sense of utilising those financial resources for preparation of high level manpower required for the purpose of economic production. This really means another question whether a low-income country such as we are should give preference to its economically active areas rather than try to spread the educational impact evenly over the population.

Educational planning is fast getting into the realm of economic planning and social thinking. It is a social science where a trained economist and a statistician as well as the scientist and the imaginative humanist must play their part in a cooperative effort to answer the question what we are educating for and how are the educated and trained men developing our economy towards the goal of self-reliance and self-sufficiency so that the structure of India's economy will enable us to produce enough goods and employment and replace old traditions or order with a dynamic and technologically advanced society to raise living standards approaching those tolerable in developed countries.

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EMPLOYMENT SURVEY OF THE ALUMNI OF GUJARAT UNIVERSITY

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1. Objectives of the Survey

The object of the present survey is to examine the relationship between the type of education at the University and the occupations which the graduates subsequently take. The survey also seeks to study the earnings of graduates, means of securing employment, mobility of employment and shifts in occupations. It also contains information about the number of unemployed graduates, the duration and intensity of unemployment in relation to different degree-holders and the number of persons not seeking work. The survey also considers how far the instruction imparted in different departments and faculties of the University is useful in the job performance of graduates. It is hoped that the findings of this survey will be useful to the University in reformulating its admission policy in the light of current demands for manpower. The data would also prove helpful in programme of employment counselling and vocational guidance.

2. Method of the Survey

The principals of colleges, the heads of institutions and faculties and departments of the University were contacted with a view to secure lists of the alumni who had passed the last examination in the year 1961. The graduates of 1961 were selected for the purpose of the survey because it was felt that these graduates would have about five years' history of employment. In all, contact addresses of 1250 graduates were

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secur[illegible] help of various educational institutions, colleges and [illegible]s of the Gujarat University. The questionnaire was [illegible] 1250 graduates but only 851 responded. Out of 851 sch[illegible]es received, 51 had to be rejected because of incomplete information. The survey, therefore, covers 800 graduates.

3. The types of examination which the alumni passed in 1961 were very extensive and hence examinations were grouped into 12 homogenous categories. The coverage according to the examination is given into the following table:

TABLE 1

Examination categories	*Number of the alumni covered*
1. B.A.	130
2. B.Sc.	104
3. B.Com.	128
4. B.E.	80
5. M.A. Languages	51
6. M.A. (History, Politics, Sociology & Psychology)	50
7. M.A. (Economics)	48
8. Master of Labour Welfare	12
9. M.Com.	38
10. M.Sc.	55
11. Law	75
12. Education	29
	800

Thus it is found that 546 graduates and 254 post-graduates were covered by the survey. Distribution of the alumni by examination categories helps to explain the relationship between education in different subjects and employment and it also highlights the connection between the type of education and the level of earnings. These aspects of the present survey are discussed separately in this article.

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4. Economic Background of the Alumni

Information relating to the family income of the alumni was obtained from 851 alumni and of these 800 gave the information as presented in Table No. 2.

TABLE 2

Family income per month	*No. of alumni*	*Percentage*
Below Rs. 100	9	1·1
Rs. 101–200	68	8·5
Rs. 201–300	105	13·1
Rs. 301–400	208	26·0
Rs. 401–500	206	25·8
Rs. 501–999	108	13·5
Above Rs. 1000	96	12·0
	800	100·0

It will be seen that the alumni are concentrated in lower family income brackets. In respect of 48·7 per cent of the alumni, the family income per mensem was below Rs. 400. It is important to note that over a fourth of the alumni belonged to the income group of Rs. 501 and above. 25·8% of the alumni belonged to the middle income group of Rs. 401–500 per month. The analysis of the family income data reveals that the higher education is not confined merely to high income brackets. About three-fourths of the alumni are concentrated in the lower and middle income brackets. It seems that education is increasingly becoming a means to improve the economic prospects of the families with low and medium incomes.

5. It was also found that 42·8 per cent of the alumni were completely dependent upon their parents or guardians for their maintenance during the course of their studies. They are generally described as non-earning dependents. 35·9 per cent of the alumni were earning dependents as they were not having an income sufficient to meet their own needs and were, there-

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forces dependent for their livelihood on the family. Only [illegible] cent of the alumni stated that their own income was sufficient at least for their own maintenance.

6. An examination of the main sources of financing education, i.e., meeting expenses including fees, books, stationery, transport, shows that the dependence on the family was very heavy. Most of the alumni were financed by their parents and guardians. Only 28 per cent of the alumni got scholarship or aid from the Government or College or University or any other voluntary agency. Loans from the caste organisations figured prominently in the case of students taking up engineering and medicine courses. It has not been possible to analyse the role of the Government, University and caste in meeting the expenses of education as the data regarding the respective roles of different agencies in the present survey were insufficient to come to any conclusion. But one thing stands out clearly that the higher education in this country is burden on the family.

7. Employment

It is proposed to examine the relation between employment and education in this section. This relationship would provide an assessment of the waste or utilization from employment point of view. We propose to examine the occupations in which the alumni are employed and also indicate their employment status

8. The alumni under consideration are grouped according to their employment status under the following categories: (*a*) an employer who runs an independent business and employs others in the business; (*b*) an employee who is employed by an individual or an organisation on the basis of remuneration; (*c*) a self-employed who is an individual who runs his own business but does not employ any one for business purposes; (*d*) an unpaid family worker who works without remuneration for at least one-third of the full time by week or month or year in an economic enterprise operated by any member of his family. As may be expected, a very large majority of the alumni under

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consideration were found working as employ[illegible] table brings out this very closely :

TABLE 3

Employment status	*Percentage of alumni*
Employee	79·5
Self-employed	10·8
Employer	5·9
Unpaid family workers	3·8
	100·0

About four-fifths of the alumni are working as employees. The next large category of employment status is that of the "self-employed". Those in the categories of employees and unpaid family workers formed very small minority.

9. We shall examine the occupations in which the alumni are distributed. The most meaningful method of presenting the data is to show how the alumni with different types of education are distributed among different types of occupation. Thus we would be able to indicate the relationship between the education and the occupational pattern of the alumni. First we shall indicate the occupational pattern of the alumni as a whole. Then we shall examine the occupational patterns of the alumni with different degrees. The following table shows the overall pattern :

TABLE 4

Occupational Divisions	*Percentage distribution of the alumni*
(1) Clerks and clerical workers	52·2
(2) Professionals and technical workers	38·8
(3) Administrative, Executive and Managerial workers	4·3
(4) Sales workers	2·1
(5) Transport & Communication workers	1·2
(6) Armed Forces	0·6
(7) Social workers	0·8
	100·0

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...ur-fifths of Arts graduates work as clerks. The patte... ation suggests that the employment prospects for Arts ... are not very bright. Another occupation which Arts graduates take up is that of teaching. Only a very small percentage of the alumni find employment in the occupation of administration, business management and journalism.

11. The occupational pattern of alumni with B.Sc. degree may now be examined. It is found on examining the relevant data that the majority of Science graduates are also employed as clerks. The following table indicates the occupational distribution of the alumni with B.Sc. degree:

TABLE 5

Percentage distribution of B.Sc. degree-holders according to the occupations

Occupations	*Percentages*
(1) Clerks and clerical workers	72·8
(2) Technical Assistants, laboratory workers	10·3
(3) Teachers	10·0
(4) Administrative and Managerial workers	2·9
(5) Salesman	4·00
	100·0

Comparing the occupational pattern of the alumni with B.Sc. degree with that of Arts graduates, it is found that the Science graduates are also employed as technical assistants, laboratory assistants and salesmen and therefore these graduates have a wider choice of occupations. But the fact remains that their education is wasted because about three-fourths of them are employed as clerks.

12. More or less similar occupational pattern is revealed in the case of the alumni with B.Com degree. 71 per cent of B.Coms. are employed as clerks, 12 per cent as accountants, 8 per cent as salesmen and the remainder are distributed

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thinly over administration, factory and busin[illegible], the ai[illegible]ment, marketing management teaching, economic [illegible]party can ign[illegible]and field work. In the case of B.Com. degree, whi[illegible]vied with e[illegible]of a general degree than B.A. degree, the proportio[illegible] clerical workers is very large. Taking all the three degrees together, it may be roughly said that three out of four graduating with one of these degrees tend to become clerical workers.

13. The occupational distribution of the alumni with B.E. degree shows that the education received by the alumni is well utilised subsequently when the alumni take to various types of the jobs. The table no. 7 shows the percentage distribution of the alumni with the engineering degrees.

TABLE 6

Percentage distribution of the alumni with B.E. Degree

Occupations	*Percentage*
(1) Engineers	56·9
(2) Engineering Assistants and related technical workers	38·2
(3) Teachers in Engineering Colleges	4·9
	100·0

The engineering degree is more specialized than the degrees in Arts and Commerce and hence its occupational spread is less than in the case of B.A. and B.Com. degrees. Those employed as technical assistants and engineering assistants replied that they believed that they would also become engineers after a couple of years.

14. The occupational pattern for alumni with M.A. languages shows that a very large majority of them are employed as teachers. 70·2 per cent of the alumni with languages were employed as teachers, 19·8 per cent as clerks, 8·7 per cent as administrative and executive workers and 1·3 per cent as social workers in voluntary organisation. Among those employed as teachers, a much larger proportion of the alumni with M.A.

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lang[illegible] employed as teachers in schools. Nearly one-fifth of [illegible] languages are employed as clerks and thus there is th[illegible]le waste in education.

15. The pattern for alumni with M.A. in History, Sociology, Psychology and Politics is marked by a very high proportion of clerical workers. 43·9 per cent of M.A. in these subjects are employed as clerks, 41·7 per cent employed as teachers, 10·5 per cent as administrative workers and 3·9 per cent as social workers. The fact that more than two-fifths of the alumni with M.A. in History, Sociology, Politics, Psychology are employed as clerks seems to indicate a very high degree of wastage in higher education.

16. Even among the alumni with M.A. in Economics the proportion of clerical workers is very large. 39·6 % of the alumni with M.A. in Economics are employed as clerks, 36·8 per cent as teachers, 16·8 per cent as administrative and managerial workers, 4 per cent as economic investigators and fieldwork assistants and 2·8 per cent as social workers. The proportion of those employed as clerks is also very large in the case of alumni with M.Com. degree. 36·2 per cent of the alumni with M.Com. degree are employed as clerks. The next large group is that of teachers — 25·9 per cent of M.Com. being employed as teachers. 22·8 per cent of the alumni with M.Com. are employed as administrative and managerial workers, 5·1 per cent as transport workers, 5·2 per cent as salesmen and 4·8 per cent as investigators. The alumni with M.Com. have, it seems, more employment opportunities in the field of transport and sales than in the case of the alumni with M.A. in Economics. But over a third of the alumni with M.A. in Economics and M.Com. are employed as clerks and this is indicative of sheer wastage of higher specialized category of education.

17. The percentage of the clerical workers is low among the alumni with M.Sc. degree. Only 8·7 per cent of the alumni with M.Sc. are employed as clerks. 70·8 per cent of the alumni are employed as scientific assistants, technical assistants and

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research assistants. 15·5 per cent of M.Sc. [illegible], the ai[illegible] as teachers. 3 per cent of M.Sc. are employed [illegible] party can ign[illegible]ers and 2 per cent in defence and allied service[illegible] vied with e[illegible] that there is a positive correlation between educatio[illegible]ed and employment secured in the case of the alumni with M.Sc. Most of them are employed in their fields of specilization. The alumni with M.Sc. replied that practical knowledge they had gained during their academic career was found to be useful subsequently in the performance of their jobs.

18. The occupational pattern of the alumni with LL.B. degree is characterized by a very high percentage of clerical workers. In magnitude, this proportion is next only to similar proportions in alumni with B.A. and B.Com. degrees. 69·3 per cent the alumni with LL.B. degree are employed as clerical workers. The reason for this very large proportion of clerks among the alumni with qualifications in law is that the alumni while employed, can attend morning and evening colleges. The large number of students obtain degree with a view to improve their occupational status. But this survey reveals that a large majority of them were unable to improve their occupational status as they were mostly employed as clerks even after taking LL.B. degree. Only 9 per cent of the alumni with LL.B. degree were engaged in the legal profession. The remaining were employed in miscellaneous administrative and managerial positions where their knowledge of law is only partially utilized. In view of the fact that LL.B. degree is a professional degree, the degree of utilization of education in occupation is very unsatisfactory.

19. The occupational pattern for the alumni with Master of Labour Welfare indicates that 64·7 per cent of them are directly engaged in the field of their specialization. But it is also disconcerting to note that 20 per cent of the alumni with M.L.W. are engaged as clerical workers and assistants. The remaining are employed as labour investigators, research assistants and administrative workers and these are the fields where education to some extent is utilized in employment. In the case

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with M.L.W. it is interesting to note that the direct field of specialization is higher than holders in civil and electrical engineering courses.

20. Means of Securing Employment

The analysis of the information gathered from the alumni regarding the means of securing employment indicates that in a large number of cases, the alumni had made use of their personal contacts and the contacts of their parents and relatives in securing employment. The response to advertisement was also an important measure of securing employment. Though the alumni had used more than one means for securing employment, it is significant to note that 32·2 per cent of them had used employment exchange as a means of securing employment. The following table shows the distribution of the employed alumni according to the means of securing employment

TABLE 7

Means of securing employment	*Percentage of employed alumni*
Through contacts	40·9
Employment exchanges	32·2
Advertisements and Public Service Commission	20·3
Teachers	6·6
	100·0

It may be noted that two-fifths of the alumni have obtained employment through personal contacts. The role of teachers in helping the alumni to secure employment appears to be very insignificant. It is found from the analysis of the data that the alumni with degree in Engineering, Labour Welfare and M.A. in Economics had depended more on employment exchanges and advertisements than on personal and parental contacts. On the other hand, the alumni with B.A., B.Com. and LL.B. degrees depended more on contacts than on employment exchanges and advertisements. Even those who used advertisements as means of securing employment stated that "contacts" had

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helped them considerably in getting employm[illegible]ar, the ai[illegible]g fact emerges from this survey that among all [illegible] party can ignore for securing employment, the use of contacts s[illegible]s vied with ea[illegible]d the one most extensively adopted.

21. Unemployment among the Alumni

It is proposed to examine now the extent of unemployment among the alumni covered by the survey. In arriving at the extent of unemployment, the time lag between completion of education and obtaining the first employment and subsequent spells of unemployment suffered by the alumni have been taken into account. It is found from the data of the survey that 8·9 per cent of the alumni are unemployed. The survey also reveals that about 72 per cent of the alumni could find employment within a year after completion of their education. The remainder, about 28 per cent had to remain unemployed for over a year. In examining the relationship between unemployment and type of the education it is found that the incidence of unemployment is largest among the alumni with B.A. and B.Com. degree. The incidence of unemployment is also very high among the alumni with M.A. in Languages and History and Politics. Table no. 8 indicates the incidence of unemployment among the alumni with different degrees.

TABLE 8

Relative Incidence of Unemployment

Degree passed	*Percentage of the alumni*
B.A.	17·8
B.Com.	16·2
B.Sc.	10·2
M A. Languages	14·3
M.A. (History, Politics)	13·2
M.A. with Economics	6·5
Master of Labour Welfare	4·1
M.Sc.	2·2
M.Com.	3·2
Law	9·2
B.E.	1·0
Average incidence	8·9

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ble reveals that incidence of unemployment is [illegible] the alumni with B.A. degree and the lowest with [illegible] B.E. degree. As regards the courses in Science and Co[illegible]ce it is found that incidence of unemployment is higher among the Bachelor's degree-holders than among the Master's degree-holders. Information was also sought from the alumni about the reasons for unemployment. Although the replies given by the alumni may be considered as subjective in nature, they are of some value in understanding the phenomenon of unemployment. About two-thirds of the alumni stated that they could not get employment because they had no influence or the right type of "contact". The next important reason stated for unemployment was that the proper job in the field of their specialization was not available. Some stated that they could not get the job because they had not secured good marks or good division in their final examinations. A few attributed lack of employment to "bad economic policy of the Government". Some attributed lack of employment to absence of vocational guidance and stated that the vocational guidance and employment counselling would have helped in choosing a course with good employment prospects.

22. Earnings and Employment

An attempt has been made in this survey to study the pattern of earnings in relation to the type of education. It is found from the analysis of the data that 72·7 per cent of Alumni with B.A. degree are earnings between Rs. 150 to Rs. 250 per monthly, 24·8 per cent are in the income bracket of Rs. 251–350 and the remaining are earning Rs. 351 and above per month. More or less same pattern of earning is found among B.Com. and B.Sc. degree-holders. 69·2 per cent of B.Com. and 60·7 per cent of B.Sc. are earning Rs. 160–250 per month. 25·2 per cent of B.Com. and 29·2 per cent of B.Sc. are in the income bracket of Rs. 251–350 and the remainder are earning more than Rs. 350 per month. Among the graduates, alumni with LL.B. are not doing any better than graduates

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in Arts, Science and Commerce. 64·3 per cent [illegible], the ai[illegible] earning Rs. 150–250 per month and 20·1 per [illegible] party can ignore Rs. 251–350 per month. The fact that most of [illegible]s vied with ea[illegible]s in Arts, Commerce and Law are employed as cleri[illegible]s is well reflected in their earnings per month. Among the graduates, engineering graduates are doing very well. 58·2 per cent of B.E. are within the income group of Rs. 351–500 per month and 29·7 per cent are in the group of Rs. 501–750 per month about 8 per cent of engineering graduates are earning above Rs. 750 per month.

23. Among the alumni with Master's degree in Arts, Science, Commerce and Labour Welfare, those with M.Sc. degree are doing better than other Master's degree-holders. 56·4 per cent of alumni with M.Sc. degree are earning Rs. 351–500 per month whereas the corresponding percentages for alumni with M A. and M.Com. and M.L.W. degree in the income bracket of Rs. 351–500 per month are 38·2, 37·1 and 49·8 respectively. 5·7 per cent of alumni with M.A., 4·8 per cent M.Com. and 14·9 per cent M.L.W. are earning about Rs. 500 per month. Most of the alumni with M.A. and M.Com. are in the income brackets of Rs. 250–350. Taking the overall view of the alumni of Gujarat University covered in this survey, it is found that 60·2 per cent of the alumni are earning below Rs. 350 per month and only 9 2 per cent have incomes above Rs. 500 per month

24. In conclusion it may be pointed out that there is very little direct relation between education and employment in the case of alumni with B.A., B.Com. and LL.B. degrees. The alumni with Engineering and Science and Labour Welfare courses seem to have utilized their education very well in their occupations as their occupational pattern reveals that these alumni are employed directly in the field of their specialization. It is also found that incidence of unemployment is very high among Arts and Commerce graduates and it is also of considerable magnitude for the alumni with M.A. in Languages, History and Politics. The examination of the relationship

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and type of education indicates that economic prospects of higher income are not very bright for the graduates and post-graduates in Arts and Commerce. The shift is unfavourable as can be seen from the facts of the survey that those with professional and scientific and practical qualifications are earning more than graduates and post-graduates in Arts and Commerce and Law.

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REGIONAL SYNTHESIS IN SOUTH ASIA—PROBLEMS AN[illegible]OSPECTS

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During the first decade and a half of the post-world war era, South Asia enjoyed considerable stability and cohesion. The region could maintain itself aloof from cold war politics; and further it could obtain increasing understanding and sympathy for its non-alignment from both the protoganists of the cold war. This is not to deny either the existence of strains and conflicts in the area or the occassional intrusions of the cold war politics into the regional issues. However, such regional strains could be contained at the regional levels and such pinpricks never developed into storm-centers. Due to its obvious importance in the emerging pattern of power politics, the region did attract considerable interest, but little anxiety.

The recent deterioration in the Sino-Indian relations has exposed the region to great strain and stress. The successful Chinese manoeuvre — military as well as diplomatic — have revealed both the vulnerability of as well as the lack of cohesion in the region. The recent Indo-Pak conflagration and the Chinese meddling in it brought home to the whole world the lack of regional cohesion in South Asia; such a situation is full of possibilities of regional chaos and outside intervention, that can upset the world power balance. The stability and strength of South Asia have not remained matters of merely passive interest; they are fast becoming the subject of world-wide concern.

The problem of regional synthesis in South Asia has assumed unprecedented importance in such a context. The pre-

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...mpts to assess the potentialities for as well as ...such a synthesis. The regional synthesis is a ... and a complex process. The strength of regionali... ...ts for functional and economic integration at the regional level, the possibilities of synthesis of interests and outlooks in the regional politics, and the pattern of consensus and conflict of the big power interests in the region — all these are the determinants of the regional synthesis. Hence, the problem of the regional synthesis in South Asia is studied here in the terms of its four major aspects — Regionalism, Economic integration, Regional politics and its synthesis prospects, and the Big Power politics. It is felt that such a four-fold approach is best suited to bring out the potentialities as well as prospects of the regional synthesis in South Asia.

I. Region and Regionalism

South Asia as a Region :

South Asia stands out as a distinct geo-political region. The chain of some of the highest mountain ranges in the world carves out the Indian sub-continent as a distinct region out of the Asian landmass. The region is refreshingly warm and wet in comparison to the arid areas of West Asia and the cold plateaus of Central Asia. These geographical and climatic distinctiveness has resulted into a very close similarity of economic, social and cultural patterns of life.

South Asia is larger than Europe in size and accounts for one-fifth population of the world. It has a land-area of five million square kilometers and the population of 582 millions.[1]

South Asia as a Political System :

Michael Brecher has evolved the three-tier system approach to the study of global and regional power politics. According to him, the power patterns of the world can be divided into interdependent but distinct systems at three levels — World System, Dominant Systems (bipolar blocs) and Subordinate

[1] See the table.

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Systems.[2] If viewed thus, South Asia can be ... distinct Subordinate System.

The South Asian System[3] operates within ... work of the adjoining Subordinate Systems as wel... Dominant systems. In conjunction with the two other adjoining Subordinate Systems of South-East Asia and China, the South Asian system constitutes "the geostrategic area of Monsoonal Asia".[4]

Internally, the South Asian System is divided into seven political entities—India, Pakistan, Ceylon, Afghanistan, Nepal, Bhutan and Sikkim. Some authorities include Burma in the South Asian System; but there prevails wider consensus for placing Burma in the South-East Asian system. The peculiarity and weakness of the system lies in the vast divergence of units in their size and power potential. The distribution of population can be roughly stated as thus : India—72%, Pakistan—16%, Afghanistan—2·4%, Ceylon—1·6%, Nepal—1·4%, Bhutan and Sikkim—negligible. The same pattern is more or less repeated in the case of land distribution. Stated in terms of thousands of square kilometers, the picture is as follows : India—3046, Pakistan—946, Afghanistan—657, Ceylon—65, Nepal—14 and Sikkim and Bhutan—negligible.[5] The emergent picture indicates the peculiar problem of the South Asian System. It is overwhelmingly dominated by one nation; and this accounts for the giant image of India that inspires fear of domination or absorption by India on the part of small states. The picture also emphasizes the key significance of India and Pakistan as basic units of regional synthesis.

The South Asian System has enjoyed a long tradition of political unity under common British domination. In fact the

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[2] Brecher : *The New States of Asia*, London, Oxford University Press, 1963, p. 93.

[3] Michael Brecher uses the term in a much more wider context of South Asia, South-East Asia and China. Here it is used in a traditional narrow sense.

[4] Cohen : *Geography and Politics in a World Divided*, N.Y., Randolph House, 1963, pp. 64–65.

[5] See the table.

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[illegible] the area coincided perfectly with the South [illegible] withdrawal of the mighty imperial power has [illegible] region divided into seven political entities. The ke[illegible] South Asia to-day is to regain by international co-operation the regional synthesis, that was once achieved by the imperial power.

South Asian Regionalism :

Such a regional synthesis on co-operative basis can be achieved only on the strength of regionalism. The unity, once imposed by the imperial power from the above, can be reestablished on the regional sentiment, springing from the below. The prospects of the regional synthesis depends vitally on the strength of such a South Asian Regionalism.

All the nations of the region do have a sense of awareness and belonging to the regional community. Anyone can observe three bases of regional unity in South Asia. Firstly, the attitude base is constituted by common political orientations about anti-colonialism, awareness of ancient past, desirability of democratic government. Secondly, the economic base is formed due to common economic problems and aspirations. Thus the problems of underdeveloped economy, over-population, unemployment are common to all; further, all nations are engaged in economic planning on vast scale. Thirdly, the defence base is reflected in the awareness of common defence barriers of the mountain ranges in the North and the Indian Ocean in the South. These three bases constitute a strong potential for the growth of regionalism in the area.

On the eve of independence and thereafter, there developed a lively interest in the geopolitical importance of the Indian Ocean for defence as well as commerce. The strategic and economic importance of this sea-lane of trade and commerce led K. M. Panikkar to evolve a scheme for a regional organization of the Indian Ocean countries under the United Nations auspices.[6]

[6] Panikkar K. M. : "Regional Organization for Indian Ocean", *Pacific Affairs*, September, 1945, pp. 246–251.

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This idea got quite a wide popularity among[illegible] as well as politicans.[7]

The thrust of the argument was well su[illegible] K. M. Panikkar :

"It follows as a matter of course that only on the basis of a regional organization of which India will be the secure and firm foundation can the safety of the Indian Ocean can be assured "[8]

In view of these factors, the concept of the South Asian Unity has been articulated quite often. G.D.H. Cole envisaged a South Asia Confederation with India as a nucleus. In his scheme of four orbits of political systems encompassing the globe, Walter Lippman pictures the South Asian orbit as one of the four.[9] Jawaharlal Nehru believed in and hoped for a South Asia Federation. Even before Independence, he said : "Small states of the world of tomorrow have no future in store and they are sure to be reduced to the status of satellite states... I stand for a South Asia Federation of India, Iraq, Iran, Afghanistan and Burma."[10] Such sentiment was also present on the side of protoganists of Pakistan. Mohamadali Jinnah hoped for 'a Monroe doctrine' for the region; further Sir Zafarulla also accepted the need for regional co-operation.[11] As late as 1960, President Ayubkhan said : "As a student of war and stategy, I can see quite clearly the inexorable push of the North in the direction of warm waters of Indian Ocean. This push is bound to increase if India and Pakistan go on squabbling with

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7 (*i*) Krishnamachari, : "Regional Arrangements", *Regionalism and Security*. New Delhi, Indian Council of World Affairs, 1948, p. 8. (*ii*) Karan P. P. : "India's Role in Geopolitics", *India Quarterly*, Vol. 9, No. 2 (1953), p. 160.

8 Panikkar K. M. : *India and the Indian Ocean*, N.Y., Macmillan, 1945, p. 92.

9 Gupta, Sisir : *India and Regional Integration in Asia*, Bombay, Asia Publishing House, 1964, p. 33.

10 *Ibid.*

11 *Ibid.*, p. 35.

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e[illegible] Ayubkhan's proposal for the Indo-Pak joint [illegible] on the realization of the indivisibility of th[illegible] as a defense unit.

[illegible] such wide-spread sentiments, the weakness of the So[illegible] Asian regionalism was obvious. The very size of India generated fear of domination on part of small states. Both Pakistan and Ceylon were apprehensive about getting closer to India. If Pakistan saw in any step for regional unity "a thinly disguised attempt on the part of the Hindu Congress to boost itself as a prospective leader of Asiatic peoples", Ceylon also feared not only domination but 'ultimate submergence' of its identity.[13] Being aware of these fears and apprehensions, India tried to underplay any talk of regional unity. Talking to C. L. Sulzberger of *New York Times* in 1957, Nehru said: "Twenty years ago I would have said that certainly we should have some kind of confederation—not federation—of independent states with common defense and economic possibility....The difficulty is now if we talk about it. This upsets our neighbours, because we are so much bigger. Nevertheless, this remains the logical future path—confederation with each member maintaining its independence intact."[14]

Search for wider Regional Identity :

Immediately after the independence, the concept of the South Asian regionalism experienced an eclipse. Both India and Pakistan were not enthusiastic about the concept due to different reasons.

From the Indian point of view, the regional unity was merely of marginal and negative importance. When India accounted for more than eighty per cent of area, population and resources of the region, such a regional unity would not bring to her any substantial increase in political power, economic advantage or international prestige. As the advantages were

[12] Ayubkhan : "Pakistan Perspective", *Foreign Affairs*, July, 1960, p. 556.
[13] Gupta : *op.cit.*, pp. 36–37.
[14] *Ibid.*, p. 108.

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negative and marginal, India was not prepa[illegible], the ai[illegible] heavy price for the unity or to push too hard party can ignore thereby fears of domination. On the other[illegible]s vied with eas fascinated by the idea of larger Asian moveme[illegible]uld add to its stature and strength. The first decade [illegible] independence witnessed this increased interest of India in West [illegible]sia and South-East Asia, that culminated in the Bandung Conference.

Fearful of its minority status in the South Asian complex, Pakistan was in search of a wider regional identity, that can counterbalance strength and stature of India. Immediately after 1948, Pakistan strived for creating a Pan-Islamic region embracing West Asia. Conceiving of a confederation of Iran, Afghanistan and Pakistan, one Pakistani scholar observed : "In this struggle for survival these three nations must come closer together.....the danger is real.....Pakistan believes that Islam itself is a nationality.....such a development is possible in this region only on the basis of Islam and not on racialism or geographic nationalism."[15]

Thus both India and Pakistan were in search of wider regional indentity. If India was attracted towards South-East Asia; Pakistan, West Asia. However, by about 1956, both had begun to realize the non-feasibility of such wider regional groupings. The rise of China presented a difficult dilemma for India in regard to wider Asian regionalism. It would either be directed against China or be dominated by it. India was neither eager to lead an anti-China front and give up its non-alignment nor to play a second fiddle to China. Hence the Indian interest in Asian regionalism cooled off.[16] The Bandung Conference proved to be this turning point. At about the same time, Pakistan also got disillusioned about its dream of Pan-Islamic unity. Its feud with Afghanistan, the rise of rival center for regional loyalty in Egypt, its military pact with the Zionist United States, the refusal of the West Asian states to equate

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15 Siddiqui, Aslam : *Pakistan Seeks Security*, Lahore, Longmans, 1960, p. 158.

16 Gupta : *op.cit.*, pp. 34–43, 50.

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friendship [illegible] Pakistan as hostility to India, reluctance of Turkey [illegible] alignment—all these led to a gradual disillusionment [illegible] a dream of Pan-Islamic Unity. The Suez crisis [illegible] anti-Nasser stand of Pakistan finally sealed the fate [illegible] search for wider regional identity.[17]

Here vital issue that emerges from these frustrations in search of wider regional identities is the resultant attitudes of India and Pakistan towards the South Asian regionalism. Will India find in it value, that is more positive and substantial? Will Pakistan realize that South Asia is the only region natural for it and consequently resign to its minority status in the region? These are the key issues in regard to the possibility of regional synthesis. Both India and Pakistan has not rejected the South Asian regionalism; but both have not found it attractive enough to be very enthusiastic about it. They have either tried to run away from it or to supersede it by wider regional loyalties. Their future attitude towards and intensity of involvement in the South Asian regionalism is a matter of conjecture. It is too premature to predict any definite trends or directions of the growth of regionalism in the area. However, it is precisely on these developments, that the future of regional synthesis depends.

II. Economic Integration—Patterns and Prospects

Importance of Economic Integration :

The functional and economic integration can play a decisive role in bringing about regional synthesis. The slow and unobtrusive process of economic integration can eventually overcome many political antagonisms and prejudices. South Asia has all the makings of developing into a distinct economic region. In fact the real difficulty of the region arises from the fact of the artificial political divisions of the naturally unified economic region.

The prospects of economic integration depend on four factors : (*i*) Patterns of economic growth, (*ii*) Patterns of aid

[17] (*i*) Das Gupta : *Indo-Pakistan Relations, 1947–55*, Amsterdam, Djambatan, 1958, pp. 234–235; (*ii*) Gupta: *op.cit.*, pp. 130–141.

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and economic dependence, (*iii*) Changing pa[illegible], the ai[illegible] (*v*) Regional co-operation and intergration. party can igno[illegible]s es vied with ea[illegible]

Patterns of Economic Growth :

All the nations in the region are faced wi[illegible] it[illegible]hon economic problems; and all aim at similar development [illegible]als. All countries are faced with the problems of over popu[illegible]ma[illegible]on, poverty, subsistence economy, and widespread illiteracy; m[illegible]nce naturally all have set their goals for increased production, rapid industrialisation and equitable distribution through economic planning.[18]

However, the differences in the resource potentials and economic needs have dictated divergent patterns of economic growth for the countries of the region. In view of its rich material resources,[19] India has concentrated on the development of heavy industries; it aspires to become an industrial giant in Asia comparable to China and Japan. India has 10 billion tons of iron, 6 billion tons of coal, the third largest reserve of manganese, and potentiality for 45 million kilowatt of hydro-electric power.[20] Thus India is destined to dominate the South Asian region as an industrial giant. This industrial potentials and designs to develop it have contributed in accentuating "the giant image" of India, that is inimical to regional synthesis.

All other nations are likely to develop agriculture and consumer goods industries. In case of Pakistan, the poor resources of basic minerals "offers little prospect of heavy industrial development."[21] Hence Pakistan has concentrated more on primary

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[18] Ginsburg : *The Pattern of Asia*, Englewood N.J., Prentice Hall, 1958, pp. 550–554.

[19] (*i*) East and Spate : *The Changing Map of Asia*, London, Methuen, 1961, pp. 146–150; (*ii*) Spate : *India and Pakistan*, London, Methuen, 1960, pp. 258–260.

[20] *Ibid.*

[21] East and Spate : *op.cit.*, pp. 166–169. Also see Ahmad : *Economic and Commercial Geography of Pakistan*, Karachi, Iqbal Publishing House, 1961, pp. 39–40.

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...ts and lighter agriculture-based industries. ...Pakistan, Afghanistan is better endowed with ... Large hydroelectric potential of the Hindukush ...siderable reserves of gas, oil and coal and chemi- ... all these bid fair for a reasonably diversified economy. Though concentrating on the infrastructure of economy during itwo five-year plans (1956–1960 and 1961–1965), Afghanistan has made beginning to lay down a modest foundation for heavy industry.[22]

Ceylon has consciously rejected the heavy industry pattern as "non-feasible for small countries";[23] and she has concentrated on development of its already prosperous plantation economy and light industries. All the three Himalayan states have concentrated mainly on agriculture, education and transport. However, they have also tried to lay down basis for diversified economy. Nepal has concentrated on jute, cotton and food processing industries; Bhutan and Sikkim are developing paper, match and forest product industries. With immense hydro-electric potential, possible mineral wealth and rich forests, these three countries can develop a stable and diversified economy.[24]

These divergent patterns of economic growth can be inter-woven into an integrated regional economy. There are good prospects of such economic integration. However, the peculiar feature of these growth patterns have created considerable apprehensions in regard to economic co-operation. Small nations are aware that their agriculture–light industry economies will ultimately become satellite economies of the Indian economy. Moreover, India is least dependent upon its neighbours even in

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[22] (*i*) Watkins: *Afghanistan—Land in Transition,* N.Y., Nostrand, 1963, p. 110–119; (*ii*) Wilber: *Afghanistan,* New Haven, Hraf Press, 1962, pp. 242–254.

[23] Ceylon Government: *The Ten-year Plan,* Colombo, Government Publications Bureau, 1959, p. 36.

[24] (*i*) Karan and Jenkins: *The Himalayan Kingdoms,* N.Y., Nostrand, 1963, pp. 44–45, 69–74, 105–106, 112–114; (*ii*) Kuhn: *Borderlands,* N.Y., Alfred Knopf, 1962, pp. 207–209.

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primary products; while its neighbours are m party can ignor the industrial complex of India. It will require es vied with ea and immense goodwill to remove such fears of nation that stand in the way of the regio it integration.

Patterns of Aid and Economic Dependence :

Economic aid and the consequent interdependence can mar a great role in economic integration of the region. Such n eventuality requires a nation in the region prosperous enough to offer aid and bring about integration on the basis of economic benefits. Unfortunately, no nation in South Asia is developed enough to give substantial aid to its neighbours.

Most of the nations are dependent for economic aid on nations outside the region. Hence the region experiences a great degree of external dependence but a negligible degree of internal dependence in matter of economic aid.[25] Thus the factor of regional interdependence for economic development is absent in South Asia.

Changing Patterns of Trade :

The trade pattern of Asia has been characterized by the external orientation rather than intra-regional orientation. During the first half of the twentieth century, merely one-third of imports-exports were carried out within the region.[26] The picture of South Asia was not much different.

However, there were considerable areas of regional interdependence. The three major shifts in this pattern of regional interdependence has weakened the prospects of economic integration of the region.

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[25] *Ibid.* Only the three Himalayan Kingdoms are heavily dependent of India for their economic development. The development plans of Bhutan and Sikkim (36 and 22 million dollars respectively) are entirely financed by India. Out of the 130 million dollars expenditure of the two plans of Nepal, India has given 60 million dollars; and the United States has given 51 million dollars through India.

[26] Wint, Guy : "South Asia : Unity and Disunity", *International Conciliation*, November, 1954, p. 175.

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Indo-Pakistani trade has worsened. If India ne[illegible] and wheat from Pakistan; Pakistan needed in[illegible] manufactured goods. Thus Pakistan directed 90[illegible] material export to India and get 70% of its im[illegible] manufactured goods from India.[27] In 1947 India also pr[illegible]ed a Customs and Excise Union. However, the dispute ov[illegible]hare of excise duties on Indian exports, the subsequent ta[illegible] Pa[illegible]war, the quarrel over devaluation — all these progressively wo[illegible]ened the picture of the Indo-Pakistani trade.[28] The discovery of Sui gas made Pakistan less dependent on Indian coal; while India sought independence from Pakistan jute by increasing jute plantation and from Pakistan cotton by cultivating the Egyptian friendship. A noted economist C. N. Vakil observed : "Politics based on communal hatred and suspicion is systematically undoing the work of generations by defying the facts of economic geography and laws of economic science."[29] Recently the situation has improved somewhat; but yet the value of the Indian exports and imports with Pakistan is only half in value of its 1952 figures.

Secondly, the Ceylonese trade has underwent a significant shift. Its specialisation is plantation crops and dependence on rice imports for food exposes Ceylon to the vicissitudes of world-price fluctuations. The rubber crisis in 1952 and the rice crisis in 1953 put a great strain on the Ceylonese economy. The pro-West government naturally turned to the United States; but it could not get sympathetic consideration from the West. Hence Ceylon entered in the Five-year Trade agreement with China for the exchange of rubber with rice on the most favourable terms that can be imagined. This incident facilitated

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[27] Spate : *op cit.*, pp. 310–311.

[28] Das Gupta : *op cit.*, pp. 50–52.

[29] Cited in Spate : *op cit.*, p. 311. Spate observed : "It seems folly for Pakistan to deliberately seek distant markets simply to hamper a neighbour with a vast actual and potential market for Pakistani goods, yet it is feared that this is being done."

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the first economic intrusion of China in the ..., the ai... relations between India and Ceylon are fairl... party can igno... last decade and an half, the Ceylonese import... vied with ea... to India have more than doubled.[31]

Thirdly, the trade pattern of Afghanistan has been ... it ing radically. Before the Indian independence, India an... were the most natural sea-access routes as well as marke... Afghanistan. Being a land locked country, it heavily de... on the access to the sea for its trade and prosperity. Ifer... it had a very close economic integration with Indian port... markets. However, the quarrel over the Pukhtunistan issue led to the progressive deterioration in these trade-patte... Pakistan thrice imposed trade-blockades on Afghanistan. Hence Afghanistan was forced to turn to Russia for trade-route as well as markets. The Russian agreements of 1950 and 1955 gave Afghanistan transit privileges as well as access to the Russian markets. During the last decade, this shift in the trade pattern has been overwhelmingly accentuated. In 1959 Russia accounted for 24 per cent of Afghanistan export and 47 per cent of Afghanistan imports. In 1961, Russia provided Afghanistan with 70% of machines, 90% of wheat and 100% of sugar.[32] "Afghanistan, of all the non-communist countries of Asia, is most dependent on the soviet trade."[33]

These changing patterns of trade in the region do not bid well for the eventual economic integration of the region. In case of Afghanistan and Pakistan, the shifts in the trade are breaking up the natural dependence of the regional units. In case of Ceylon, the increasing Chinese economic influence may possibly orient Ceylon more towards China and away from

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30 For details see Wriggins : *Ceylon : Dilemmas of a New Nation*, Princeton, Princeton University Press, 1960, pp. 404–408.

31 Abeyesekra : "Economic Apartheid", *Far Eastern Economic Review*, September 21, 1961, pp. 585–586.

32 (*i*) Nollau and Wieche: *Russia's South Flank*, N.Y., Praeger, 1963, pp. 118–125; (*ii*) Wilber : *op.cit.*, pp. 263–290.

33 Nollau and Wieche : *op.cit.*, p. 125.

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...tem. These developments are progressively ...tors of the regional trade from comple- ...petitive — from intra-regional orientation to in... ...ientation.

...al Co-operation and Integration :

...he need of regional co-operation and co-operation has ... generally recognized by the states in South Asia. The ... Five-year Plan of India views planning in the regional ...pective and emphasizes the need of mutual adjustment and ...plementary specialization. Ceylon has repeatedly shown ...ire for regional co-ordination to prevent duplication of efforts ...d to encourage specialization.[34]

In spite of such hopes and desires, no institutional framework has been created for regional co-operation and co-ordination. The Colombo Plan is far from such an integrated institutional structure; it is not a plan at all but "an envelope covering the development programmes of member countries."[35] Being purely conceived on bilateral and ministerial level, it has not fostered strong economic regionalism.[36] In spite of its more integrated regional approach, the ECAFE also have not proved very effective in this direction.[37]

The most discouraging fact is the reluctance of the member-states for any more integrated and regional arrangement. Such an attempt for regional planning was seriously considered in 1955 at the Simla Conference of the Colombo Plan; however it failed to win approval. As the *New York Times* commentator Rosenthal observed : "But a major result of the Simla Conference has been to show that most countries of Asia are not ready for, or are afraid of, regional planning."[38] According to him, one of the major reasons of the failure was

[34] Abeyesekra : *op.cit.*, pp. 585–586.

[35] Gupta : *op.cit.*, p. 80.

[36] *Ibid.*, pp. 78–80.

[37] Wint : *op.cit.*, pp. 181–182.

[38] Cited in Gupta : *op.cit.*, p. 81–82.

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"the fear, among some, that India would beco[illegible] The attempt for regional co-operation was [illegible] the ECAFE Conference at New Delhi. It a[illegible] the fears of small nations. Both Ceylon and P[illegible] it on the ground that "it should not mean the co[illegible] of complementarity".[40]

Evidently the attractions for regional co-operation a[illegible] in a position to outweigh the apprehensions about it.

Economic Foundations of the South Asia Regionalism :

This survey of the various patterns of the economic [illegible] of the region indicates the weakness of the economic foun[illegible]tions of the South Asian regionalism. The strains are obviously developing between inward oriented economy of India and outward oriented economies of other nations. The divergence between the heavy industry-oriented Indian pattern and the light industry-oriented pattern of other countries also generates apprehensions and strains The intra-regional trade is almost stagnant; and the regional interdependence almost negligible. As all the nations are underdeveloped, the scope of mutual help is highly limited. Fear of domination by gigantic India, economic nationalism, anti-foreign feelings, largely competitive economies—all these are handicaps to the economic integration of the region. As early as 1949, the Conference on South Asia at the University of Chicago concluded : "During the presentation of the various positions, the merits of diversification versus specialization in economic developments were debated inconclusively. On the other hand, there seemed fairly general agreement that the area as a whole did not present the feature of an economic region, however defined. Such foundation as existed in the area for regionalism had to be sought in spheres other than economic."[41] The above assessment may seem too

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[39] *Ibid.*

[40] *Ibid.*, p. 83.

[41] Talbot (ed.) : *South Asia in the World Today*, Chicago, Chicago University Press, 1950, p. 145.

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stic. However, it can hardly be denied that regionalism in South Asia are weak; and the mic integration in near future, far from bright.

Regional Politics—Areas of Conflict

e survey of the regional politics reveals many areas of t, that are generating strains in the South Asian System. ef account of these conflicts will be worth its while.

ems of Minorities :

Political divisions of natural culture regions resulted into tantial minorities everywhere. These created the suspicions ut the extra-territorial loyalties on part of the minorities, with resultant strain among most of the nations of the region. The most important of these problems was one of the Indians in Ceylon. Over a period of 100 years, the Indian Tamils have migrated to Ceylon as plantation labourers. The movement was encouraged by the plantation owners; however the Delhi government had put a ban on any further immigration since 1941 due to the ill-treatment meted out to Indians. However, the Indians constituted ten per cent of the total population of Ceylon by 1953. Under the upsurge of Sinhalese nationalism, the Ceylon goverment enacted the Citizenship Act in 1948; it virtually excluded Indians from citizenship rights. The deadlock continued for over a decade and many inter-governmental efforts failed. The leftist orientation of these Indian workers inhibited the rightist government in extending franchise.[42] The issue considerably strained Indo-Ceylonese relations. Fortunately, the solution has been found in November of 1964. According to the Indo-Ceylonese agreement, India will take back 55% of the Indians gradually within fifteen years; and Ceylon will grant citizenship rights to 30% of the Indian population. The fate of the remaining 15% will be decided later through further negotiations.[43]

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[42] (*i*) Wriggins : *op.cit.*, pp. 224–228; (*ii*) Abhayawardhan Hecter : "Ceylon", *Seminar*, September, 1962, pp. 35–36.

[43] *Organiser*, November 9, 1964, p. 9.

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Thus a great irritant between India and Ceylon ... ar, the ai... party can ign... sil- At present there are no other significant mi... s vied with ea... gn the region. ... and ... it as

Tribal Areas—Pakistan :

The tribal areas of Pakistan on the North-West fr... constitute a very thorny question. The Durand Line de... mani- the boundary between India and Afghanistan in 1893. It l... emain follows the water-shed of Indus; but it cuts across the e... fer of groups of pathans, inhabiting both sides of the mountains. ... ien r, Durand Line has been cause of great strain between Afghani... ping and Pakistan. Pathans form 60 % of the total population ... ng Afghanistan. As the Durand Line leaves five million Pathans in Pakistan as against 8 million in Afghanistan, there is a great irredentist sentiment in Afghanistan. Since 1947 Afghanistan has rejected the Durand Line. In spite of the fact that the plebiscite of 1947 favoured the cause of Pakistan, neither the Pukhtunistan movement nor the Afghanistan's crusade for it have abated. It should be noted that large sections of Pukhtuns boycotted th... plebiscite, because it did not provide an option for union wi... Afghanistan. Hence neither Afghanistan nor Pukhtuns hs accept... the validity of the plebiscite verdict. The intensity of Afghanistan opposition was reflected in its vote against the Pakistan's admission in the United Nations. The quarrel has resulted into frequent war-like actions, trade-blockades, and severance of diplomatic relations. The one-unit formula of the 1955 Constitution created the most acute crisis. Since then Afghanistan has veered more and more towards Soviet Union for its support on the Pukhtunistan issue. Since 1955 Russia has consistently supported Afghanistan on this issue.[44] The whole issue seems impossible of solution. If Afghanistan insists on ethnic homogenity and self-determination; Pakistan can well insist on the long-standing treaties and strategic defense needs. The intrusion

[44] (*i*) Watkins : *op cit.*, pp. 55-57; (*ii*) Wilber : *op.cit.*, pp. 174-184; (*iii*) Gupta : *op cit.*, pp. 141-142; (*iv*) Nollau and Wieche : *op.cit.*, pp. 108-109.

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...litics have atrophied the issue further. The ...e a perennial source of irritation in the region.

...ndia :

...as tribal population of 29 million people. It is however ...areas in Assam, that have become a serious problem. ...accounts for 2·1 million of the tribal population.[45] The ...istration of the Assam tribal areas is divided in three ... (*i*) The state of Nagaland : The sixteenth state of the ... Union was inaugurated in December of 1963. It has a ...lation of 300,000. (*ii*) Autonomous Tribal Areas of Assam : ... area is governed according to the sixth schedule of the ...onstitution; it has one regional council and five district ...ouncils, with three-fourth members elected by adult franchise. (*iii*) The North-East Frontier Agency : The NEFA is a union ...erritory and its administration is carried by the President ...hrough the Governor of Assam. The area has no elected legi...lature but advisory councils in each of its five districts.[46]

The vast tribal area of Assam has proved to be quite ...aceful, except the Nagaland. The Nagaland, with an area of ...000 square miles and population of 357,000, has proved to be the most difficult and intractable problem. The Naga tribes are spread over both sides of the Indo-Burmese border. With the 700,000 Nagas on the Burmese side, they constitute an area of 10,000 square miles with population of one million. The Nagas have been agitating for the independent and trans-border state of their own.[47] The Nagas had put up the demand of their own state even before the Simon Commission in 1929 and the Cabinet Mission in 1946. In 1947, the National Naga Council, led by A. Z. Phizo, declared the independent and sovereign state of Nagaland. But Sir Akbar Haidari, the Governor of Assam,

[45] Sarkar : *Hindustan Yearbook, 1964,* Calcutta, Sarkar and Sons, 1964, p. 350.

[46] *Ibid.*, pp. 124, 347 (also see Part II, pp. 7, 52, 54).

[47] Barua, Hem : *The Red River and the Blue Hill,* Gauhati, Lawyer's Book Stall, 1962, pp. 147–151.

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negotiated an interim arrangement for ten [illegible], the ai[illegible] a lengthy period of peace and harmony. H[illegible] party can ignc[illegible]sil- NNC declared revolt, established a paralle[illegible]s vied with ea[illegible]gn conducted guerilla warfare. As the situation w[illegible] and was called in. Since then a continuous trouble i[illegible] it as area.[48]

Since 1957, the Nagas have been split into the two mani- of the extremists and the moderates. The moderates [illegible]emain of the terrorist activities and wanted to accept au[illegible]fer of within the Indian Union. They established the rival [illegible]ien[illegible], the Naga Peoples Convention.[49] In response to the dem[illegible]ping the NPC, the Indian government constituted Nagaland [illegible]ing sixteenth full-fledged state in December of 1963. Since [illegible] the moderate Nagas have been satisfied; but the extremists a[illegible] still carrying on the agitation. The policy of the Indian gove[illegible] ment had been three-fold in regard to this difficult proble[illegible] (*i*) to give utmost autonomy within the Indian Union, (*ii*) make continued attempt to reconcile the Naga extremists, (*iii*) speed up the economic development of the area.[50] During last few months, the Nagaland Peace Mission, compose[illegible] Jayaprakash Narain, Assam Chief Minister and central go[illegible] ment secretary, are making serious efforts to negotiate reconcile with the underground Nagas. In spite of all efforts, t[illegible] problem has eluded solution so far. Recent revolt of Mizo tribes almost follows the pattern of the Nagaland problem.[51] These problems of tribal areas should be viewed as those of incomplete national integration. They present challenge as well as opportunity to integrative genius of India. Unlike the issue of the Pakistan tribal areas, the issue of tribal areas in India has not been complicated by the intrusion of the cold war politics.

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[48] (*i*) Patterson : *Peking vs. Delhi*, N.Y., Praeger, 1964, pp. 181–136; (*ii*) Elwin : *Nagaland*. Shillong, Adviser's Secretariat, 1961, pp. 51–56.

[49] *Ibid.*

[50] Elwin : *op.cit.*, pp. 45, 93–99.

[51] For details see "Behind the Miz. Rebellion", *Link*, March 13, 1966, pp. 19–24.

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nity of Nagaland and Mizo areas to the se borders makes them highly sensitive areas nse.

States :

iew of the Chinese menace, the three Himalayan states sumed great significance. All the three states lay on the vide n slopes of the Himalaya mountains. India is in charge Pa nce and foreign affairs of Bhutan and Sikkim. Nepal is P ndent state; but India has given unilateral guarantee for sco ense.[52] The Indian policy in regard to these Himalayan oal is to build up their defense and strategic communication ne side and to carry out rapid economic development on e other side. It also maintains a delicate balance between pporting the monarchies and at the same time persuading em to be more responsive to democratic aspirations. Inspite occasional demands for more autonomy and grumblings out Indian domination, Indian relations with Bhutan and kkim can be considered largely satisfactory.[53]

But India's relations with Nepal have been far from happy. nview of its immense strategic importance for the Indian nse, India has a vital stake in its security as well as bility. Hence India has to maintain a delicate balance between respect for Nepal's independence on one side and concern for India's security on the other. This peculiar relationship was well expressed by Jawaharlal Nehru : "Geographically Nepal is almost a part of India, although she is an independent country..... Any possible invasion of Nepal would inevitably involve the safety of India."[54] These dilemma between the need of interference and the respect for independence was further accentuated by the struggle between autocratic and democratic forces in Nepal.

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[52] Patra Saral : "Special Obligations", *Seminar*, September, 1964, pp. 25–31.

[53] Karan and Jenkins : *op.cit.*, pp. 53–55, 77–78.

[54] Cited in Karunakaran : *India in World Affairs*, Calcutta, Oxford University Press, 1958, pp. 11–12.

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If on one side Nepal had a political [illegible]er, the ai[illegible] hereditary monarchy and hereditary prime-[illegible] party can ign[illegible]sil- other hand it had a well developed democrati[illegible]s vied with ea[illegible]gn the Nepali Congress. The clash between the [illegible] [illegible]and sympathized by the King and the Rana autocra[illegible]r [illegible]it as about the first Indian intervention in the Nepalese a[illegible] 1950. Under the Indian advise, the King Tribhuvan inti[illegible] mani- a new constitution and formed a broad-based governmer[illegible]emain subsequent decade witnessed chronic political instabili[illegible]fer of rapid succession of governments. In the first general elien[illegible]r, held in 1959, the Nepali Congress won 73 out of 109 [illegible]oing no other party could come near it in performance. Howing King Mahendra could not pull along well with the popus ministry. In December 1960, King Mahendra staged a cou[illegible] arrested prime-minister and suspended parliament. Subsequently King has introduced a new constitution embodying "guide democracy" based on four-tier structure and indirect elections.

The royal coup in 1960 and its criticism in the India press has resulted into a pathetic deterioration of the Ind[illegible] Nepalese relations. The anti-Indian feeling, never entirely abs[illegible] has increased to an alarming proportion. Extreme sensiti[illegible] to Indian domination, the autocratic and vainglorious personal[illegible] of King Mahendra, Indian advocacy of democracy, the dissatisfied Rana elements, suspicion of India's hand in making and breaking the successive cabinets, occasional mismanagement of Indian aid, dependence on India for more than 95% of its trade—all these have contributed to these anti-Indian feelings.[56] However, the existence of anti-Indian feeling should not be overemphasized. Although no one deny the anti-Indian sentiment in the Katmandu Valley, the majority of the Hindi-speaking people of the Terai—nearly 60 per cent of the total population—are pro-Indian. In the mountain areas outside the Katmandu Valley, people generally follow a friendly policy

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[55] For details see Karan and Jenkins, *op.cit.*, pp. 89–93.

[56] *Ibid.*

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ex-army Gurkha soldiers stand by India.[57] feeling is more at the royal and aristo- than at the popular level. This is amply remarkable electoral success of the Nepali

ever, the Nepalese government is considerably anti- nd it has shown some signs of flirtation with China and . Evidently Nepal has no love lost for China; in fact it. But King Mahendra wants increasing international ion and is skillfully playing a non-alignment role n India and China. The Lhasa–Katmandu high road, after Mahendra, and the 1963 trade agreement with istan are evidences of the new shifts in Nepal's foreign ations.[58] The big power politics has entered the Nepal itics with all its rewards and risks. China has given 30 lion dollars aid as against 60 million dollars of India and million dollars of the United States.[59]

Though by all accounts serious, the situation need not undue alarm. There are obvious limitations to the inde- nt course of Nepal. The framework of the Sino-Indian ontation, that has made the Nepalese flirtation possible, constitutes the limits of the Napalese manoeuvre.

Strains and Synthesis :

These various areas and issues of conflict are creating considerable strains in the regional politics. To that extent they impede the synthesis of South Asia. The problems, surveyed here, are on the whole peripheral and soluble. Barring the Pukhtunistan issue, none has been characterized by either intense emotional involvement or irreconcilable interest conflict. Given good will and diplomacy, these strain-spots can be liquidated and the regional synthesis can be facilitated.

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57 *Ibid*, pp. 122–124. Also see Patterson : *op.cit.*, pp. 142–144.

58 *Ibid.*, p. 123.

59 *Ibid.*, p. 114.

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IV. Regional Politics—Indo-Pak Re

Key to Regional Synthesis :

However all these problems pale into insignific... viewed in the context of Indo-Pak relations. By very na... of things, India and Pakistan are the most natural units ... rigional integration. No regional synthesis is possible in abse... of close co-operation and harmony between these two natio... The prospect of regional synthesis in South Asia will ul... mately hinge upon the possibility of working out close ar... harmonious relationship between India and Pakistan.

Patterns of Conflict and Co-operation :

The partition of the Indian sub-continent created many problems between the two successor states. The communal massacres claiming 500,000 lives, the subsequent refugee movements on both sides dislocating more than 16 million people, the dispute regarding evacuee property left in both countries by the migrating refugees (8000 million dollars in Pakistan and 800 million dollars in India), the dispute regarding the use of canal waters, the boundary disputes arising from the different interpretation of the Radcliffe Award, the disputes regarding Junagadh and Hyderabad[60]—all these disputes flowed from the partition and were responsible for considerable strain and hostility on both sides. The disputes were highly complex; both sides could find enough justifications to support their stands.

However, most of these problems have either been solved or become dead issues for all practical purposes. The refugees have been mostly rehabilitated in their new surroundings; they have ceased to be an explosive element. The long standing Canal Water Dispute was solved in September 1960. The allocation of the Indus System waters in 80 : 20 proportion between Pakistan and India, the ten-year period for carrying out transi-

[60] (*i*) Das Gupta : *op.cit.*, pp. 42–43, 60–74, 188; (*ii*) Hasan : *Pakistan and the United Nations*, N.Y., Manhattan Publishing Co., 1960, pp. 37–39, 85.

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...nts, and the international guarantee for the ... are the broad features of the settlement, made ... the mediation of the World Bank.[61] The hurri... frequently imprecise Radcliffe Award have created ... difficulties and disputes. Ever since the Nehru-Noon ...ment in September 1958, the considerable progress has made in settling border disputes. The Nehru-Noon agree... surveyed all the border disputes, settled most of the dis... regarding the eastern border, and laid down procedure to ...e the remaining disputes.[62] The Border Settlement of ...uary 1960, disposed off many disputes of the western border. ...spite of all these efforts, the difficulties have persisted in two respects: (*i*) The implementation of the agreed transfers of Berubari and Cooch-Bihar enclaves have been delayed due to the challange to its constitutional validity. However, the Indian government have assured that it would even change the constitution, if needed, to implement its promise. (*ii*) The dispute in regard to Rann of Kutch have eluded solution. Both these ...reas have recently been scenes of military hostilities and poli... cal strain. The Pakistan intrusion in Kutch and the threatened ...arge-scale hostilities (April, 1965) underlined the explosiveness of such a situation. The Indo-Pakistan agreement on the Kutch problem has eased the tention and have left the solution of the dispute to the International Tribunal. Early solution of such tiny disputes are imperative to remove the sources of pernnial pinpricks.

In spite of these disputes, the relationship pattern between India and Pakistan is slowly returning to functional normali... ation. The easing of travel restrictions, the series of recent trade-agreements, the Indo-Pakistan Press Code Agreement (November, 1960) are the hopeful signs of the evolving pro-

[61] Hasan : *op.cit.*, pp. 45–47.

[62] Nehru : ***India's Foreign Policy***, Delhi, Publications Division, 1961, pp. 492–494.

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cess of economic normalization.[63] Richard Park ... ar, the ai... party can ign... of evidences to discern this emerging trend ... s vied with ea... operation in spite of political hostilities. Howe... ance of this hopeful trend is limited. "It is ... than mutually convenient and useful co-operative rela... —no step towards political and cultural integration of S... Asia."[64]

The prospects of expanding the trickle of functiona... operation and economic normalization into the stream of ... tical co-operation and harmony will depend on the solutio... the Kashmir dispute. The recent Indo-Pak conflict (Septemb... 1965) highlights the pivotal importance of the Kashmir issu... for the Indo-Pak rapprochement. The Pakistani infiltration in Kashmir, the crossing of the ceasefire line by India, the Pakistan attack in the Chamb area, the spread of the conflict to Punjab and Rajasthan areas, the sub-continental war of twenty-two days, the U.N. resolution of September, 20, 1965, and the subsequent ceasefire of September 22 — these events are too recent and well-known to need elaboration. The Tashkent Summit (January, 1966) between Pakistani President Ayubkhan and Indian Prime Minister Shastri has been a memorable landmark in the directions of normalization of relations as well as progressive rapprochement. The Tashkent declaration has generated a new atmosphere of mutual good-will and hopes of more cordial relations. In such a context, the amicable solution of the Kashmir problem assumes paramount importance.

Kashmir — Issues and Attitudes :

The facts of the Kashmir issue are relatively simple. Kashmir was one of the five hundred and odd native states of India. With the lapse of British Paramountacy, its ruler was entitled to make choice in regard to either accession or independence. In view of its geographic contiguity, it could have

[63] Richard Park : "Functional Co-operation and Political Conflict", *Far Eastern Economic Review*, September 21, 1961, pp. 580–581.

[64] *Ibid.*

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[illegible] the new states; and in view of its size and [illegible]d have remained independent. On one side the [illegible]ja feared joining the Muslim Pakistan. On the [illegible]is personal relations with Jawaharlal Nehru and [illegible]ical relations with the Congress were far from cordial. [illegible]h supported the National Conference of Sheikh Abdulla, [illegible]t was anti-Maharaja as well as anti-Muslim League; the [illegible]est of Nehru by Maharaja in 1946 testifies this hostility and [illegible]picions.[65] Hence the Maharaja could not make up his mind [illegible]d decide about accession before August 15, 1947. Both [illegible]heikh Abdulla and Maharaja were thinking in terms of choice between the accession to India or independence; none exhibited any enthusiasm about joining Pakistan. As Sheikh Abdulla and his National Conference have fought successfully against Jinnah and his two-nation theory since 1936, the accession to Pakistan would have been his political suicide. However, from the point of view of religion and geography, Pakistan had impressive claims.

The exasperating vacillation on part of the Maharaja, the deterioration in relations with Paskistan, the invasion of tribals supported by Pakistan, the accession of Kashmir to India (October 27, 1947), the Indian army in Kashmir, the Indian complaint to the Security Council about the Pakistan invasion (November, 1947), the appointment of the UNCIP, the cease-fire (January 1, 1949)—all these events are too well-known to need elaboration.

The United Nation's efforts to solve the Kashmir dispute resulted into the two resolutions of August 13, 1948 and January 5, 1949. Both India and Pakistan accepted the resolutions. The resolutions outlined three stages of ceasefire, withdrawal of troops, and plebicite. Short of naming Pakistan an aggressor, the resolutions made vital concessions to the Indian position.[66] The

[65] Bazaz : *The History of Struggle for Freedom in Kashmir*, New Delhi Kashmir Publishing Co., 1954, pp. 168–172, 261–262.

[66] For details of concessions made to India see Brown : *The United States and India and Pakistan*, Cambridge, Harvard University Press, 1953 pp. 168–169.

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...ar, the ai... Pakistan withdrawal was to be first and com... party can igno... sil- territory was to be administered by "the l... es vied with ea... gn under the supervision of the Commission, ... and government was recognized as the legitimate gov... it as the Plebicite Administrator was to be appointed under ... authority, India was to withdraw the bulk and not the ... of its forces.[67] ... mani-

However the deadlock soon arose in regard to the ... emain pretation of various aspects of these resolutions. The differ... fer of mainly related to the status of Azad Kasmir forces, ...ien r, procedure of the withdrawal of forces, and the status of ...ping Northern Areas.[68] ...ing ...s

The series of the United Nations efforts proved futile. The McNaughton Proposal (1949), The Dixon Mission (1950), the Graham Mission (1951–53), the Jarring Mission (1957), the second Graham Mission (1958)—all these efforts tell the story of frustrations and failures in the search of a way out from this deadlock.

The U.S.-Pakistan military pact in 1954 stiffened t... Indian position in regard to the plebicite; moreover the pa... encouraged Russia to support the Indian stand in Kashmi... Since then Kashmir has become a cold-war issue; its solution had been rendered much more difficult. The national prides, psychological complexes, the cold-war politics, emotional frenzy —all these have turned Kashmir into a problem of utmost complexity and tender sensitivity.

There were some hopes of the settlement of the issue in wake of the Canal Water Treaty in 1960. Further immediately after the Chinese invasion, the Kashmir issue was re-opened and the most sincere efforts were made to solve it. Both these efforts failed; and both India and Pakistan returned to their old fossilized positions. The Kashmir dispute exploded into

[67] For text see Bazaz: *op cit.* 431–433.

[68] For details of these differences see Das Gupta: *op.cit.*, pp. 109–110, 124–128.

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wake of Pak infiltration into Kashmir in The subsequent twenty-two days war highlight- nce of the Indo-Pak rapprochement and the on of the Kashmir dispute. The Tashkent agree- consequent thaw in the Indo-Pak relations promises ide favourable conditions for the solution of this long- ng dispute.

nir — Alternative solutions :

t is really impudent and amateurish to suggest solution ne problem, that has defied solution for more than fifteen s. Over the course of years, the respective stands have ssilized; and the attitudes, atrophied. If Kashmir is a test of its secular ideology for India; it is also a logical corollary of the two-nation theory of Pakistan. If the liberation of Kashmir is the compelling slogan in Pakistan; that of vacating the aggres- sor, in India. If India can remind Pakistan of its aggression; the Pakistan can remind India of its duplicity on the question of plebicite.

If the solution of Kashmir is to be the basis of the Indo- kistani harmony, it must be just and equitable. Any solution, at may leave a sense of frustration or bitterness on either ide, can only widen the existing gulf. Such a solution must not be conceived in a spirit of victory or defeat but in that of equitable compromise. Hence the solution will have to take into consideration : (*i*) reconcilability of national interests and st nds, (*ii*) capacity of the nations to make concessions to th bring about such reconciliation. The search of such a solution here s the task, that seems impossible.

So many suggestions have been made in regard to the solution of Kashmir. One suggestion is to create an indepen- dent political entity of Kashmir with full sovereignty, the inter- national supervision, the Indo-Pakistani condominium or the three-partite confederation. All these solutions are not practic- able. Either condominium or confederation requires similarity of outlook and abundance of goodwill between India and

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Pakistan, that is precisely lacking. Such ..., the ai... likely to be center of intrigues, conflicts a... party can ign...sil- not likely to result into harmony. Furtherm...s vied with ea...gn Kashmir in a suspended animation. It will ne... ...and tegrated with India or Pakistan nor be completely ... it as In view of the Chinese menace and the Indo-Pakistani ties, the independent Kashmir will also constitute a ... mani- rather than strength to the South Asian System. ...emain

This leaves the prob'em with three possib'e so'u...fer of (*i*) status-quo, (*ii*) Plebicite, (*iii*) Partition. The first is ...ien..., ously ruled out; because if it would have been acceptable, ...ping would be no Kashmir problem. The second solution of plebiing is the best; if possible. Both India and Pakistan has accepts the international obligation to abide by the verdict of th people. Hence it accords with the stands of both parties. Neithe the plebicite nor the loss of Kashmir as a result of it wil harm the prestige or stand of either nation. Even if it is a defeat it is one at the hand of the people and not at the hand o the opponent. If both the nations are prepared to risk th eventual loss of Kashmir, a plebicite is the most honourab way out.

However, this does not seem to be possible. In view the Chinese menace, India will not be in a position to with draw its forces from Ladakh; and this also involves military use of the routes to Ladakh through the Kashmir valley. But the most cogent argument against plebicite is that the adverse verdict of plebicite may worsen the relations rather than improv ing them. In spite of the verdict of plebicite, the Pukhtunistar issue is yet alive. Plebicite can solve the problem if its verdic is accepted in good grace and with open mind; but if there doubt regarding such preparedness, plebicite is a dangero- gamble not worth its while.

Considered from all ang'es, the partition seems to be ...hem most practicable, if not the best solution. If India has rec... ed to the loss of the Punjab plains, Gilgit, Hunza and P... er 30,

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...n has reconciled to the loss of Jammu and ...he present ceasefire line more or less follows ...ver it departs from natural geo-political fea... ...aces and hence needs to be rectified to bring ...t of the natural frontiers of these distinct geo... units of Kashmir. The Kashmir valley is an area, where ...s of both are irrencoilable. In any scheme of partition, ... have to be partitioned. A line between Nandadevi ...in and the Pir Panjal range bisecting the Wular Lake ... the most natural line possible for partition of the valley. ...a division has the merit of giving the feeling of partial ...ry to both the sides and of defeat to none. It also preserv... the strategic interest of India in the Kashmir valley. If the ...main principle is agreed upon, the details can easily be worked ...ut with mutual accommodation. The proposal is largely in line ...with the partition plan of Sir Owen Dixon.[69] It is also instruct... ...ve to note that both the sides have considered the variations ...f this plan whenever a serious attempt is made to found ...a realistic political settlement". The six rounds of the Bhuto... ...varansingh talks in 1962 made this evident. The moment ...h the nations gave up their slogans of plebicite and cease... ...line status-quo; they were forced by logic to the talks of ...rtition. In fact during the third round, India offered the ...artition of the valley along the Wular lake line. If the Pakistan would not have been too ambitious and obdurant, the ...solution would have been found. When the Indian partition ...proposal left 34000 out of the total of 85000 square miles with ...akistan; the Pakistan proposal only left 3000 square miles with ...ndia.[70] As India has already made the proposal under the Nehru ...gime, the present government can justify such a solution ...ainst public outcry.

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[69] For details of the partition plan and its geo-political advantages see ... Madhok: *Kashmir—Centre of New Alignments*, New Delhi, Deepak ...lan, 1963.

[70] (*i*) Brecher: *op.cit.*, p. 182; (*ii*) *New York Times*, February 9, ...1.

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Whether the Kashmir issue will be sett... ...er, the ai... or not is not certain. However one thing is p... party can ign... sil- if it will be solved at all, it would be solved ...s vied with ea... gn indicated above. ...and ...it as

V. Regional Politics—Indo-Pakistani Rapprochem...

Divergence of Outlook and Orientation:

Though the importance of the solution of the dispute... mani- the Indo-Pakistan rapprochement can hardly be exaggerate... emain would be a great mistake to equate such solutions with ...fer of desired rapprochement. In most of the cases the disputes ...ien r, the consequences rather than the causes of the Indo-Pakis... ...ing hostility.[71] In the interview with Michael Brecher, Jawaharlal Nehru said: "Many people think and say that the Kashmir problem is a major problem which comes in the way of good relations between India and Pakistan. That is true to a sense, but not basically true....and even if the Kashmir problem was solved....those basic conflicts would continue."[72] There is much truth in the above observation. The forces and factors that underlie the Indo-Pakistan hostility, are too complex an... too deep-rooted in mutual attitudes and images to be equate... with few disputes. Hence, "it is a fantastic to discuss Indi... Pakistan relations in the context of their disputes alone without tackling the more deep-rooted problems posed by the fact that India and Pakistan have entirely different images of each other and themselves."[73]

Attitudes and Images:

The basic problem of the Indo-Pakistan relations is the one of Pakistan's undefined and unadjusted status in the South Asian complex. If the fear of Hindu domination made the birt... of Pakistan inevitable; the fear of Indian domination is impe...

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[71] (*i*) Callard: *Pakistan: A Political Study*, Allen and Unwin, 1... p. 314; (*ii*) Hagan: *op.cit.*, p. 50.

[72] Brecher: *op.cit.*, p. 209.

[73] Gupta: "Pakistan Sector", *Seminar*, September 1964, p. 17. ...er 30,

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...cal adjustment of Pakistan to its place in ... any realistic evaluation of the rapprochement ... vey of these basic motivations is inevitable.

...ogical conflict: The ideological cleavage between ... and Pakistan constitutes the basic difference in their ...ation and outlook. The struggle between the two-nation ...y and secularism has not yet ended; the only difference ...at the internal struggle has been externalized. Their ...gent views on the partition and Kashmir spring from this ... orientation difference. It is interesting to note that ...istan refused the joint electorate to the Hindu minority, ...t the minority demanded even at the risk of being dominated ...y the Muslim majority.[74] Evidently the grant of joint electorate would have meant the rejection of the two-nation theory.

(*ii*) *Past rivalry and bitterness:* The present hostility and rivalry between India and Pakistan have been to a large measure a continuation of the pre-partition rivalry between the Muslim League and the Congress. Thus the political rivalry ... the pre-partition India naturally tended to become interna-...nal rivalry.[75] The memories of the struggle for independence ... for Pakistan, that are the primary source for nationalism, ...re full of bitterness and hostility. This is a psychological impediment of considerable magnitue.

(*iii*) *Strains of integration:* Since inception, Pakistan ...nherited an almost impossible situation from the point of view ...f integration. Except Sindhi, all its sub-nationality groups were ...ivided between India and Afghanistan. Moreover the East ...akistan is separated from the political nucleus of Pakistan ...t only geographically but also economically and culturally.[76]

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[74] Das Gupta : *op.cit.*, p. 219.

[75] (*i*) Callard : *op.cit.*, p. 15; (*ii*) Gupta : *India and Regional Integration* ..., *op.cit.*, p. 37.

[76] (*i*) Spate : *op.cit.*, p. 311; (*ii*) Ginsberg : *op.cit.*, p. 661.

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er, the ai
. Such a difficult situation has not only ger party can ign sil-
integration but also genuine apprehensions a s vied with ea gn
of the East Pakistan. The threat of secession and
subsequent abrogation of parliamentary governme it as
tions of such difficulties.[77] In this context, there are und
able apprehensions that normalization of relations with
may draw the East Pakistan more in the Indian orbi mani-
away from the West Pakistan. emain

fer of
(*iv*) *Fear of domination :* In view of the long sta ien r,
tradition of cultural harmony and the geo-political absu ing
of Pakistan, the movement of Pakistan flourished on the i ing
of Hindu domination. It is very significant to note that th
Muslim League was powerful only in the muslim-minority
provinces. The Muslims in the Muslim-majority provinces had
nothing to fear about the Hindu domination; because they would
constitute majorities in their areas in any scheme of federation.
Hence the Muslim League had no domination fear to exploi
in the areas, that were ultimately to form Pakistan. Th
explains the poor electoral performances of the Muslim Leag
in these provinces before independence[78] Prior to 1942,
Muslim League could not form ministry in any of the Musli
majority provinces. It is irony of fate that the Muslim Leagu
derived its strength from those areas, that were never to form
part of Pakistan and that it was weak in the areas, that
ultimately formed it. This fear of domination, that was over
whelming base for the creation of Pakistan in face of geo
political and cultural compulsions, also remains the basis of it
continued existence. Any weakening of this fear is bound
weaken the rationale of Pakistan. If in pre-partition days t

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[77] Wint : *op.cit.*, pp. 142–143.

[78] (*i*) Brown : *op cit.*, pp. 134–135; (*ii*) Ram Gopel : *Indian Musl*
A Political History, London, Asia Publishing House, 1959, pp. 2 hem
(*iii*) Wilcox : *Pakistan—The Consolidation of a Nation*, N.Y., C
University Press, 1963, pp. 30–35. er 30,

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d the enemy-image; in the post-independence
me the enemy-image giving the basic strength
nationalism.

ear of normalization: Alexander Hamilton observed
hat the artificial divisions of the country, united by nature,
e maintained only by artificial tensions.[79] No other obser-
n could be more true in regard to the Indo-Pakistani
ons. In view of the geographic and cultural factors working
loser union, it is a Herculean task to preserve artificial
ions and identities The process of normalization can be
l to the existence of such units. Maintaining that Pakistan
d no other security against the natural tendency of one
government absorbing another in a topographical basin, Aslam
Siddiqui says : " To escape the consequences of this axiomatic
development Pakistan has to put up some shield. That shield
obviously is religion, on the basis of which partition of the
Indo-Pakistan subcontinent took place."[80] Evidently the shield
s also artificial political tension and the enemy-image of India.

(*vi*) *Search for prestige and parity:* The psychological
ability of Pakistan to settle down to the status of a smaller
ate in the South Asian complex is the great obstacle to the
Indo-Pakistan rapprochement. Any suggestion of superiority or
inequality between India and Pakistan is an enigma to Pakistan.
During the pre-independence struggles, the Muslim League
always demanded parity between the 25 per cent Muslim mino-
rity and the rest of India. It was the realization that the
Muslims will not get parity with Hindus in the United India,
hat became the most powerful motivating force behind the
mand of Pakistan. " The inter-communal status conflict, one
mbolized by the League's demand for parity between the
per cent Muslim minority and the rest of India, now

three. Cooke (ed.) : *The Federalist*, N.Y., The World Publishing Co., 1961,
able. 176.

of ou Siddiqui : *op.cit.*, p. 17.

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ar, the ai
became an international status conflict."[81] F party can ign sil-
lusioned to realize that the international eqts vied with ea gn
nations is a legal fiction rather than political and
the external world cool to it and unprepared t it as
against India.[82]

This search for parity and prestige have taken two manifestations: (*a*) Pakistan encouraged Indian states to remain independent with a view to balkanize India. Jinnah's offer of blank cheque to the rulers of Jodhpur, Bikaner and Jaisalmer, the Pakistani encouragement for the independent Hyderabad, acceptance of accession of Travancore—all these are evidencing of the Pakistani desire to balkanize India and thereby to negatively achieve parity by reducing the stature of India.[83] (*b*) The other manifestation of this search of parity is the attempt to be a part of the larger regional units that can counterbalance India in stature and strength. Its search for such a regional unit of alliance have fluctuated its enthusiasm for various political alliances—the British Commonwealth, the Pan-Islamism the United States and the friendship with China.

This pathetic pre-occupation with prestige and parity well reflected in the incident of violent Pakistani reactions to the suggestion of the Vice-President Johnson that India can be a natural leader of Asia. The United States had to accord Ayubkhan a great reception as the Asian military leader compared to George Washington to mollify the Pakistani feelings.[84]

The above survey of the six basic motivations behind the Indo-Pak relation pattern reveals that the real nature of the problem is more psychological than political. The fear of domination or ultimate submergence and the persistent preoccup-

[81] Gupta : "Pakistan Sector", *Seminar*, September, 1964, p. 25.

[82] Callard : *op.cit.*, pp. 302–304.

[83] For details of these Pakistani attempts and motivations behind them see (*i*) Gupta : *op.cit.*, p. 18; (*ii*) Wilcox : *op.cit.*, pp. 32, 47–43.

[84] Selig Harrison : "George Washington Ayub", *New Republic*, October 30, 1961.

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—these are the major impediments in the way of rapprochement. The future of mutual harmony and co-operation hinges on the possibility of as well as the capacity of the respective nations for the liquidation of these psychological complexes.

Prospects of Rapprochement :

In view of the above mentioned attitudes and inhibitions, the chances of the Indo-Pakistan rapprochement depends on the preparedness and capacity of both nations to make necessary adjustment.

The political picture of India in this regard is fluid and somewhat confusing. An attitude survey of the Indian Parliament in the late sixties revealed a heavy pre-occupation of the members of the Parliament with domestic affairs. However in the field of foreign policy problems, the problem of Kashmir and Pakistan figured prominently.[85] This shows that the Indian politicians are not pre-occupied by the Kashmir and Pakistan; yet the same time they are not indifferent to it. One can discern the two lines of Indian political thought in regard to the muslims and Pakistan. The Gandhian approach has been one of accommodation and adjustment with the sub-continental brothers; the other one has been one of tough and realistic policy towards Pakistan.[86]

The Gandhian approach has been largely followed by Nehru, Shastri and the centrist section of the Congress. They would like to reach accommodation with Pakistan, if it does not involve politically indefensible solution. Outside the ruling party, the Swatantra Party led by Rajaji and the Sarvodaya movement led by Jayaprakash Narain are the most earnest and articulate advocates for the Indo-Pakistan rapprochement. Though the political base of these groups is limited, both Rajaji and

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85. Free : *Six Allies and a Neutral*, Glencoe, Illinois, Free Press, 1959, pp. 9, 10, 16.

86. Gupta : *op.cit.*, pp. 27–28.

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Jayaprakash are widely respected; their advocac[illegible], the ai[illegible]reating the atmosphere for a friendly accommodation party can ign[illegible]

On the other side, the anti-Pakistan gro[illegible]s vied with ea[illegible]ed over the course of time; and it has developed sig[illegible]sted-interest in domestic policy. The Janasangh is the rightist party with the orientation of the Hindu communalism; hence its anti-Pakistani stand is easily understandable. The communists and the leftist wing of the Congress has exploited anti-Pakistani feelings to fan up anti-West and anti-American crusade. The Kashmir and the enemy-image of Pakistan are very convenient and handy tools for the leftists to stop India from slipping into the western orbits. Hence we see in India a baffling phenomena of the anti-Muslim rightists and anti-American leftists joining hands in anti-Pakistan crusades. The rightist wing of the Congress is joining with these forces with a view to challenge the centrist elements in power.

This picture of attitude-pattern has undergone considerable change during the early part of 1965. Growing American impatience at Pakistani flirtation with China led to grave deterioration in U.S.–Pak relations. The United States cancelle[illegible] President Ayubkhan's U.S. visit abruptly and declared i[illegible] inability to commit any aid for the new Five-Year Plan o[illegible] Pakistan until the whole gamut of U.S.-Pak. relations is reviewed closely. The consequent anti-American outbursts in Pakistan gladdened the hearts of Indian communists. They saw in the situation a distinct possibility of drawing Pakistan out of the American alliance and of creating non-aligned Pakistan. Hence they began to plead for accommodation and adjustment with Pakistan. The Russian efforts to improve its relations with Pakistan at the same time strengthened Indian communists in their new leanings. The Tashkent Summit and the Russian role in it have engendered new enthusiasm for Indo-Pak rapprochement among Indian communists, particularly the right communists, and the leftists in the Congress. Party reactions to the Tashkent declaration follow this pattern. The Janasangh

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Praja So[illegible] and the Samyukta Socialist Parties opposed the dec[illegible] left communists were more eager to endorse the [illegible]rochement with a view to promoting similar rapp[illegible]ith China.

Thus the Swatantra party, the Sarvodaya and Gandhian elements, the centrist and leftist forces in the Congress, the right communists and perhaps the left communists — all these political forces are likely to support and strengthen any move for reasonable accommodation with Pakistan. On the other hand, the tough policy towards Pakistan is advocated by the Janasangh and Indian Socialists. The Congress rightists may throw their weight on the side of such forces, if they gather momentum.

The latitude of the Indian accommodation to Pakistan will ultimately depend on the emerging balance between these two counterveiling forces. However, the pro-Pakistan attitude has gained momentum recently. The growing Chinese menace is slowly working out its logic in popular imagination. The utmost importance of Indo-Pakistani friendship is becoming too obvious [illegible] be refuted. Even a leading leader of the Janasangh came [illegible]t with a suggestion for the partition of Kashmir to accommo[illegible]te Pakistan.[87] Moreover, "the advantage lies in the fact that [illegible] India none can easily discard such ideas as antagonistic to India's interest; the national leadership was on record against Pakistan and Gandhi once said that Partition would come over his dead body. Further, the very martyrdom of Gandhiji reminds [illegible]is utmost sincerity for the Indo-Pakistan rapprochement. In short [illegible]t is impossible for any one in India to reject reasonable schemes [illegible]or such co-operation without disowning the tradition of its [illegible]ational struggle." [88]

The picture of the political scene of Pakistan is not clear. It [illegible]s very difficult to identify and assess the forces working for

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[87] Madhok : *op.cit.*

[88] Gupta : *India and Regional Integration in Asia, op.cit.*, p. 113.

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or against the co-operation with India. However, the anti-India slogans pay uniformly rich dividends and no party can ignore it. In the recent election, both the parties vied with each other in exploiting anti-India sentiments.

Obviously there are inherent potentialities for the Indo-Pakistani rapprochement. However the limiting factors are equally powerful. The utmost earnestness and tactfulness are imperative for the achievement of the synthesis between India and Pakistan.

VI. Big Power Politics—Aims and Impacts

Outside Cold War Arena :

During the immediate post-world-war era, all the states of the South Asian system exhibited remarkable similarily of outlook towards the Cold War and its participants. Anti-colonialism, the general distrust of Western powers, the absence of perception of any fear from the communist world, the desire to be left alone so as to concentrate on the nation-building tasks and the eagerness to assert and display the newly won independence in international affairs—all these motivation factors were dominant in almost all the nations of the area. Barring Ceylon, no nation evinced any keen interest for military pacts. The Ceylonese defense treaty of 1948 with England was quite understandable. Ceylon was too small and week to control the Indian Ocean on one side; while on the other side, its safety and prosperity depended exclusively on the protection of the Indian Ocean. Its exposed nodal position in the Indian Ocean and its heavily maritime oriented economy made Ceylon extremely vulnerable. Hence she entered into the defense treaty with England in 1948.[89] However, this relationship remained purely defensive and limited in nature. The world outlook of Ceylon remained largely similar to that of the other South Asian states.

The South Asian states evolved a neutralist or non-aligned foreign policy stance. Even Pakistan followed the policy of

[89] Wriggins : *op.cit.*, pp. 389–391.

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"qualified neutrality"; it recognized China, pleaded for its admission in the United Nations and voted against naming China an aggressor in Korea.[90] Afghanistan also followed the neutralist path. During this period, conflicts and strains in the regional politics were by no means absent; but such conflicts never got involved into the big power politics.

On their part even the big powers were not very eager to project themselves in the region. Their pre-occupation in Europe and Far East on one hand and their initial distrust of nonalignment on the other hand impeded both their interest as well as their involvement.

The Entry of Big Power Politics:

The 1954 military pact between the United States and Pakistan marked the entry of the big power politics in the region. Though ostensibly anti-communist, the pact had implicit anti-Indian overtones. On the study of the recent biography of Richard Nixon, Selig Harrison observes: "It leaves little doubt that Nixon urged this alliance not for its reported defense value against Soviet aggression but for the only reason Pakistan has sought aid—as a counterforce to the confirmed neutralism of Jawaharlal Nehru's India."[91] Partly as a counter-offensive and partly to exploit anti-American feelings generated in the subcontinent, Russia moved in in the big way. It is interesting to note that Russia supported the Indian stand on Kashmir and the Afghanistan stand on the Pukhtunistan issue only in 1955. Since 1955 the Russian policy has remained to stabilize the region around non-aligned Afghanistan and India.

In the long run the American policy in the region proved to be more strenuous and embarassing. Its tie up with Pakistan antagonized both India and Afghanistan. Immediately after

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[90] Mustaq: *Government and Politics in Pakistan*, Karachi, Pakistan Publishing House, 1963, p. 231.

[91] Selig Harrison: "Case History of Mistake", *New Republic*, August 10, 1959.

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the Pakistan military pact, Afghanistan approached the United States for armaments. When the request was turned down by the United States, Afghanistan turned to Russia. Since then the Russian influence in Afghanistan has been increasing rapidly.[92] In terms of aid and trade, Afghanistan of all the non-Communist countries of Asia, is most dependent on Russia.[93]

Pattern of the Big Power Co-existence :

However by the late sixties, the interests of the United States and Russia had largely converged; both wanted to help and strengthen the non-aligned nations in general and India in particular. As Malenbaum observed, India became a laboratory of economic co-existance between East and West.[94] In 1960, Jawaharlal Nehru could proudly boast : "This makes India itself a kind of an area of agreement between the opposing ideological forces."[95] Thus Russia and America both showed increasing appreciation of India and found in it the area where their interests can converge and co-exist.

It is precisely this development that made the local allies of these two super-powers restive and resentful. Both China and Pakistan became increasingly critical of such an appeasement of neutrals at the cost of the faithful allies.

The Growth of Sino-Pakistan Axis :

The deterioration in the Sino-Indian relations brought about a new dimension of the big power intrusion into the South Asian system. The Sino-Indian conflict has exposed the system for the first time to the big power, that has geographic contiguity with the region. The assessment of Chinese aims in the region and motivations behind them remains a complex and highly controvertial issue. However even highly divergent assess-

92 Watkins : *op.cit.*, pp. 87–88.

93 Nollau and Weiche : *op.cit.*, pp. 118–125.

94 Malenbaum : *East and West in India's Economic Development*, Washington, National Planning Association, 1959, p. 3.

95 Gupta : *op.cit.*, p. 24.

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ments of the Chinese designs reveal agreement on some points. From the view point of such wide agreement, few points in regard to the Chinese aims in the region stand out clearly: (*i*) the favourable settlement of the border dispute; (*ii*) the political offensive against India with a view to reduce its potentiality or image for Asian leadership; (*iii*) the extension of political hegemony over the Himalyan states and their isolation from India; (*iv*) the exploitation of the South Asian conflicts and strains to embarrass and handicap India.[96] It is clear that China would not miss any opportunity to weaken India and to capitalize on the sub-continental disputes involving India.

In this over all objective, China found a natural ally in Pakistan. By 1959, Pakistan had been largely disillusioned about the value of the American military pact. The pact alienated Russia as well as the Arab world; the Kashmir issue became more hopeless with the Russian veto; and America showed disinterested neutrality and preached the "no threat from India" thesis.[97] In deteriorating Sino-Indian relations Pakistan saw the possibility of cultivating a friend, that was equally uncompromising in its opposition to India and superior to India in strength and stature. The friendship with China will satisfy the two basic urges motivating the Pakistan foreign policy — the fear of domination and the search of parity. A Pakistani scholar observed: "She (Pakistan) cannot rely for her protection on a distant ally who is more friendly to her most dangerous enemy... Pakistan's own security therefore lay in seeking an arrangement with the power which could effectively check the expansionist tendency (of India) and only power that could do was China."[98]

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[96] (*i*) Brecher: *op.cit.*, p. 171; (*ii*) Fisher: *Himalayan Battleground*, London, Pall Mall Press, pp. 145–146; (*iii*) Patterson: *op.cit.*, p. 52, 274–276; (*iv*) Husdon: "Dragon towards Bhutan", Paul (ed.): *Our Northern Borders*, New Delhi, The Book Times Co., 1963, pp. 119–120.

[97] (*i*) Mustaq: *op.cit.*, pp. 235–236; (*ii*) Hasan: *op.cit.*, pp. 75–76.

[98] Mustaq: *op.cit.*, pp. 239, 277.

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This Sino-Pakistan axis is the most disturbing phenomena from the point of view of the regional synthesis in South Asia. The earliest arrest of this trend is vital for the safety and stability of the whole region. It is precisely this develoment, that has given the edge of urgency to the problem of the South Asian synthesis.

VII. Regional Synthesis — Problems and Prospects

Importance of the Synthesis :

The stability and security of any regional system ultimately depend upon the harmony and mutual co-operation among the members. In view of the fact that South Asia is fast becoming a sensitive spot of world-politics, the regional synthesis of the sub-continent has assumed added urgency. The political, economic and military co-operation on one hand and the fostering of the common world-outlook on the other hand are the two basic pre-requisites for the regional unity. Even the existence of South Asia as a distinct geo-political region is largely dependent on such regional synthesis. "For the greater geo-political unity on the Indian sub-continent is the best means of preserving its current independence, and of preventing the absorption of the region within a possible Monsoonal geo-strategic realm that would in all likelihood be dominated by China."[99]

Potentialities for the Synthesis :

South Asia as a region possesses ample potentialities to develop into a powerful geo-political force. The distinctive regional personality as a result of relative physical isolation from the Asian land mass, the identical climate and economic patterns, the common aspirations about economic progress and international prestige, the tradition of political unity for over hundred years under the imperial domination, and reasonably strong feeling of South Asian regionalism — all these are obvious but oft-forgotten bases for the regional synthesis. It is the great pontentiality of regional integration, that makes the partition

[99] Cohen : *op.cit.*, p. 184.

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and political hostilities in the region poignantly pathetic. No objective observer would deny that South Asia has abundant potentiality for the regional synthesis and integration.

Problems and Hurdles :

However these potentialities connot automatically be expected to create the regional synthesis. Though the potentialities in the long-term sense are immense, the actual possibilities in the short-term are not highly encouraging. The path of the regional synthesis is full of many hurdles, some of which are quite formidable.

Firstly, the wide divergence in the sizes and power-potentials of the states in the region is the greatest impediment. The mutual co-operation and good will become far more easy in a region like Europe, where the states are of more or less equal size. The "giant image" of India and the subsequent fear of domination on the part of small states have generated psychological complexes, that are difficult to dissolve. These complexes have retarded the forces of regionalism as well as of economic integration.[100]

Secondly, the regional synthesis does not hold out dazzling economic advantages. Even if united, the South Asian states will not form a self-sufficient unit from the point of view of economic growth. The economies of the South Asian nations are competitive as regards to exports, imports and foreign aid.[101] In the case of the Organization of American States, the United States could overcome the handicaps of its 'giant image' due to its immense capacity to hold out large-scale economic help. No state in South Asia, at present, has such a capacity. Hence, there are no strong economic advantages, that may impel the tates for the regional synthesis.

Thirdly, the absence of military threat or the lack of identic a perception about it constitutes another impediment. If the

[100] Gupta : *op.cit.*, pp. 86–88,
[101] *Ibid.*, pp. 94–95.

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Chinese threat becomes more real, it may bring about such identity of threat-perceptions. However in case of Pakistan, even such an eventuality is doubtful. Moreover even the unity is not likely to bring them independence or self-sufficiency in military matters. The very fact that even after the regional integration they will have to depend on outsiders for economic and military strength undermines the desire for synthesis.

Fourthly, the intrusion of the external power in the region has made the synthesis much more difficult. The United States and Russia impeded the regional synthesis in the initial stages by injecting the cold war politics in the regional conflicts. However of late, they have adopted a much more constructive and co-operative attitude towards the regional harmony and growth. But the same cannot be said about China. It has indicated all the willingness to fish into the sub-continental troubled waters at the slightest invitation. The presence of China with readiness to encourage obduracy and opposition to India in the sub-continent reduces the preparedness on part of smaller states to make sacrifices for accommodation and encourages the temptation to blackmail this little cold war between China and India.

Fifthly, the difficulty of Pakistan in adjusting to its place in the South Asian complex is the main hurdle in the regional synthesis. Her persistent pre-occupation with the parity status has tempted her to run away from her minority status in the complex of South Asian realities. Its long Odyssey in search of larger political identities, that can counterbalance India, has ultimately led her into the embrace of China. Once Pakistan compromises with relatively smaller status, it will realize that its rightful place belongs in South Asia. "It is not conceivable that Pakistan can solve either its problem of identity or its problem of status by joining any other regional association. Pakistan essentially belongs to South Asia and shares its problems and aspirations."[102]

[102] *Ibid.*, pp. 119.

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Prospects for the Regional Synthesis in South Asia :

This survey of possibilities and problems of the regional synthesis in South Asia should make one aware of the magnitude of the task; but it need not generate defeatism or despair. The short term prospects are clouded by some formidable hurdles; but the potentialities for such a synthesis are too encouraging and the stakes involved too high to accept defeat. Given efforts, good will and tact, the regional synthesis can be achieved in South Asia, that may turn the region into an area of strength and stability in the pattern of world politics.

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South Asia—Table of Relevant Statistics*

Country	Area (thousand square kilometers)	Population (millions)	Density (per sq. kilometer)	Rate of Increase (per cent)	Literacy (per cent)	Urban Ratio (per cent)	Industrial Prod. 48	Industrial Index 62	Agricultural Prod. 52	Agricultural Index 62
India	3046	449·0	148	2·3	24	18·0	64	138	90	121
Pakistan	946	96·5	102	2·1	19	10·0	48	144	97	115
Afghanistan	657	14·6	22	3·1	6	5·0	—	—	—	—
Ceylon	65	10·4	159	2·7	56	15·2	—	—	106	121
Nepal	140	9·5	68	—	—	—	—	—	—	—
Bhutan	47	0·7	15	1·9	—	—	—	—	—	—
Sikkim	7	01·6	23	2·4	—	—	—	—	—	—
South Asia	4911	582·3	—	—	—	—	—	—	—	—
Asia	—	—	—	—	—	—	35	178	93	118
World	135 773	3135	23	1·8	—	—	62	129	94	117

*The table is constructed on the basis of the following sources :

(*i*) United Nations : ***Demographic Yearbook, 1963***, pp. 374, 375.

(*ii*) United Nations : ***Statistical Yearbook, 1963***, pp. 31–33, 78, 116, 634.

(*iii*) Ginsberg : ***The Pattern of Asia***, N.Y., Prentice-Hall, 1958, pp. 547, 550–554.

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IMPORTANCE OF INTERVIEW AS A METHOD OF RECRUITMENT IN THE INDUSTRY

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"Right man for the Right job" has become a slogan in the industry. Both employers as well as employees have realised that a deserving, qualified capable man should be placed on the job. It is the ability of an individual, which makes him successful. An employer benefits by a proper selection of the candidate for a job. As Dale Yoder says, "The purpose of interviews as used in selection is, of course, to distinguish those believed likely to prove satisfactory from potentially unsatisfactory employees. At the same time, many employers regard the interview as an opportunity to improve public relations by impressing candidates with the desirable working conditions and relationships in the firm...."[1]

On the side of the employee, if he is rightly selected, then he profits more from the job. He enjoys the work and he gains more from his work experience. An individual tries to develop his capacities so that he reaches up to the climax. He craves for higher status and ultimately his development adds in the development and growth of the industry.

In order to arrive at a right selection employers are trying out various methods of recruitment. Interview is the oldest and still the better method of selection in the modern industries. As Joseph Tiffin in his book on industrial psychology describes, "..The interview, in spite of its limitations, occupies an important place in the majority of employment offices. It would thus

[1] Dale Yoder: *Personnel Management and Industrial Relations,* Prentice Hall, Inc. (U.S.A. 1958), p. 235.

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seem that in spite of, the possibilities of error inherent in the interview as a technique, it has certain advantages that account for its long continued use."[2]

There are number of techniques and forms of an interview. Different people look at an interview from different angle. In spite of all the criticisms for an interview as a method of selection, the use of interview by the employers is inevitable.

The major forms of an interview are: (1) Group interview, (2) Individual interview, and (3) Board interview. In a group interview number of candidates are interviewed at the same time and at one and the same place. The greatest advantage of this type is that it is economical both in terms of money and time. From the point of view of an interviewee, he becomes less self-conscious because he is along with others. The disadvantage of the method is that minute observation of an individual may not be possible. It looses a chance of intimacy.

In the case of an individual form of an interview, one candidate is interviewed at a time by one man or by many. The advantage is that the most of the required information regarding an individual's abilities can be secured. The disadvantage is that it takes a lot of time. An interviewee might become self-conscious. "...The basic difficulty of this type of interview, as usually conducted, is that it involves making extensive inferences from limited data obtained in artificial situations by unqualified observers. The person is interviewed for a limited period of from about 20 to 60 minutes. He is seen away from his regular surroundings. He comes to the interview in a special frame of mind, influenced by his desires and expectations and does not demonstrate his regular approach to problems. All of these are difficulties attached to the interview."[3] Said Paul Pigors, Charles Myers and F. T. Malm.

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[2] Joseph Tiffin: ***Industrial Psychology***, George Allen and Unwin Limited (London 1951), p. 24.

[3] Paul Pigors, Charles Myers and F. T. Malm: ***Readings in Personnel Administration,*** MacGraw Hill Book Company, Inc., Second Edition (New York 1959), p. 223.

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If it is a board interview where only one candidate is interviewed by a board of experts in the field, then an interviewee is fully tested from different angles. In such a case, an interviewee should be fully prepared, for the ordial and an interviewer should be trained for the technique of interview.

On the basis of the past experience of different interviewes certain basic conditions are laid down for making an interview successful. Such conditions can be described as follows :

(1) There should be a specific place for the interview. The place should be selected in such way that an interviewee feels comfortable.

(2) There should be certain time limit for the interview. Both the candidate as well as the interviewer should feel that they have gained something at the end of the interview. If it is a hurried interview within a very short time limit, then a candidate feels that he is not tested properly and the interviewer feels that important information is missing. If it is a very long interview then both the interviewer and the candidate get bored.

(3) An interview should be well planned. Only questions pertaining to the job should be asked. No direct or pointed question should be put forward. Again personal questions should be avoided as far as possible.

(4) Since interview is a technique, the first step of an interview is to establish Rapport, where by both an interviewer and an interviewee become professional friends. As John Mee describes, "..first attitude that the interviewer should keep in mind, is one of cordiality and attentiveness toward the applicant. The interviewer, who displays interest and sympathy in what the applicant says, is attentive to the whole story and refrains from interrupting the applicant, will generally get the information, he requires and leave the applicant with a good impression of the interviewer and the company.[4]

An interview aims at giving the information, getting the information and making friends. In this connection an interviewee

[4] John F. Mee : *Personnel Hand-book*, The Ronald Press Company (New York, 1955). p. 454.

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should be enlightened regarding the policy of the company, so that he knows basic rules and regulations governing his employment.

Above discussed factors give us an impression that an interview is a scientific procedure. In order to make an interview successful the interviewers should be qualified for the interview. An interviewer should be trained for taking an interview. He should have a thorough grasp of the job or subject for which he takes an interview. He should be well conversant with the policy of the industry. Over and above this he should have a deep insight into human nature, so that, he understands himself as well as others. In certain cases, interviewers are trained for the technique of interview, so that an intervierwer's error or his personal prejudice may not come in the way of selection of the right man. As Scott Clothier and Spriegel put it, "The native capacities of the interviewer in training are important. The interviewer should possess ability, experience, a balanced emotional life and genuine interest in people....".[5]

Even though an interview is taken at the beginning, means while selecting a candidate for the job, at certain places, interview is used at various stages, and different forms of an interview such as—

(1) Preliminary Employment Interview, (2) Placement Interview, (3) Transfer and Promotion Interview, (4) Routine Administrative Interview, (5) Grievance Procedure Interview, (6) Counselling Interview, (7) Interview for selecting a candidate for training, (8) Follow-up Interview, and (9) An Exit Interview are used.

[5] Walter D. Scott, Robert C., Clothier and William R. Spriegel: ***Personnel Management Principles, Practice and Point of View***, McGraw Hill Book Company, Inc., Sixth Edition (New York, 1961), p. 99.

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OUTPUT AND PRODUCTIVITY CHANGES IN INDIAN INDUSTRIES, 1951–1958

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1. Introduction

The object of planning is to initiate a process of development which will raise the living standards and open out to people new opportunities for a richer and more varied life. This can be achieved by efficient exploitation of the resources of the country and by increasing production in the various sectors of the economy. For this achievement, one of the objects of planning was to make rapid industrialisation with particular emphasis on the development of basic and heavy industries, S. Gupta [1] and Nicholson and Gupta [2] have worked to measure the productivity and output changes in British manufacturing industry. The present work comprises a part of study of post-plan changes in Indian industrial structure. The purpose has been to provide index numbers of output and productivity to measure their changes during the planning years 1951–1958. The factor which is largely responsible for enormous increase in production in last few years has been due to continuous increase of modern and automatic machines. The labour is able to turn out more output during a specific period of time if we work with more efficient and technical change. The changes in output during a specific period are usually measured in terms of labour productivity. The analysis carried out here has the main purpose to determine the extent to which manpower productivity, output and capital investment have increased during the planning years 1951 to 1958. The present study covers the Statistical data relating to all the Indian industries coming under the industrial Act for the years 1951 to 1958.

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The data are published in the Census of Indian Manufactures [4] for various years.

2. Method and Definitions

For the sake of clarity, a brief review of the method and definitions is presented here. Gross output is the value of the production total. Value added by manufacture has been considered as the value of net output. Value added by manufacture is computed by deducting from the gross ex-factory value of output, the value of at factory of fuel and materials used, work done for factory by other concerns, and depreciation of fixed assets. In order to study the trend of output the gross output index has been calculated at constant prices for the year 1955 and 1958, (1951 = 100). The price values from the census report have been deflated by using the appropriate index numbers of whole sale prices published in Eastern Economists and Monthly abstract of Statistics. The year of 1951 has been considered as a base year for all the indices as it is beginning year of the first Five-year plan. Net output is an income concept and the real increase should be in net output rather than in gross output and hence the net output index has been calculated at constant prices for all industries for 1955 and 1958 (1951 = 100). The index numbers of net output measures the change in the amount of 'work done' in each industry, defined as the difference between its output of products and the input of materials from other industries, that is to say, to measure the change in 'net output' content of output. We require more capital investment for the expansion of an industry and to replace old machines by new more technical machines. In order to study the trend of capital investment, capital index has been calculated for 1955 and 1958 at constant prices with (1951 = 100). For the present study, capital is defined as the total productive capital (i.e., fixed capital + working capital). Warking Capital has been included in the capital because it is important in some minor industries which do not require fixed capital as that of major industries. M. C. Jaiswal [3] has calculated the distribution of

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capital in Indian Industries, which gives the idea of investment between the industries while this index will give idea of investment of the same industry during the period 1955 to 1958. In order to study the trend of total man-hours the man-hour index has been calculated for 1955 and 1958 for all industries (1951=100). It will show whether the total man-hours have increased or decreased during these years. They should increase due to the expansion of the industries but they decrease because of the modern automatic machines as the same worker can operate more machines at a time. Man-hours have been defined as the estimate of the number of man-hours worked by a factory during the year and is calculated by multiplying the number of workers employed in each shift by the number of hours in the shift and aggregating the products for all the days in the year. The figures for man-hours are given in the census reports.

Labour productivity, though the word has a wider meaning, has mainly been used in its strict and simple definition as the output per labour unit. It is commonly measured in terms of relative number of man-hours required to produce equal physical quantity of goods at two different periods, or inversely, it is measured in terms of Physical quantity of goods produced per man-hour in different periods. The units of measurement of the various commodities of production is different and hence the comparison of physical quantities per man-hour is not possible. Hence it has been measured in terms of the value of goods produced per man-hour at two different periods. Therefore the value of net output per man-hour has been considered as the measure of productivity. The value of the output have been deflated by the use of an appropriate index number of whole sale prices in order to convert these values at constant prices. The gross output per man-hour has been calculated for 1951, 1955 and 1958 for all the industries at constant prices in order to study the change in productivity during the years 1951–1958. The (gross-output) productivity index has been calculated for 1955

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and 1958 (1951=100) from it. Only the index values are given here as it serves the purpose for our conclusion. The gross-output productivity is useful to study the trend of the same industry during different years. The inputs of the various industries are different, hence the gross-output productivity does not throw any light to compare the productivity between the various industries. Net output is independent of the input in a sense that it gives the increase in the value of the product due to the manufacturing process. (∵ it is the value obtained by substracting the value of input from that of gross output, i.e., it is the value added by manufacture). Hence, net output gives the idea of income concept also. In order to compare the productivity between various industries and within the industry during 1951–1958 net output per man-hour has been calculated for 1951, 1955 and 1958 at constant prices.

In order to know the increase in productivity in terms of percentage and as it is easier also to compare productivity between and within various industries, the productivity index (net output) for 1955 and 1958 (1951=100) has been calculated for all industries.

The Index Numbers and Productivity

The index numbers of gross output, net output, capital and man-hour as defined above have been calculated at constant prices for all 29 industries for 1955 and 1958 (1951=100) and are given in Table 1.

Gross output index :

The study of Table 1 reveals that the gross output index has mostly increased for all industries from 1951 to 1955 and 1958. This index increases for some industries and decreases for some other industries from 1955 to 1958. This index for all industry total is 133 in 1955 and 134 in 1958, i.e., it has increased by 33% and 34% in 1955 and 1958 respectively. So we can conclude that the gross production has increased by about 33% from 1951 to 1955 but it has not increased from 1955 to 1958. The maximum value of this index is that of

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bicycles. It is 487 in 1955 and 685 in 1958. It indicates that the demand for bicycles has increased very much. The consumption of bicycles is nearly five times in 1955 and seven times in 1958 in comparison with that in 1951. The bicycles are generally consumed by lower middle and lower class of people. So it can be concluded that the lower class of people can afford to own a bicycle now. This indicates the progress in economic development due to planning as it has raised the standard of tne lower class of people. The next maximum increase in this index is in sewing machines. This is because of the household need of a family. The stiching charge has gone up and due to the raise in prices the people feel short of their income and hence they stich their clothes at home as far possible. Now a days so many tailoring classes have been started even by the community development project to train the ladies to stich the clothes. So that they may save the expenditure and use the under utilised time in stiching the clothes. This also shows the development during the plan period. If we consider important industries, this index for cotton textiles is 125 in 1955 and 104 in 1958, i.e., it has increased by 25% from 1951 to 1955 but decreased by 21% from 1955 to 1958. This may be due to the fact that the production and consumption of artificial fibres have increased much now a days resulting the decrease in demand of the cotton clothes. This index for woolen textiles has increased by 26% in 1955 and by 39% in 1958. This indicates the consumption of woolen clothes has increased during this period. This index for Jute textiles has decreased by 21% in 1955 and 34% in 1958. This is the only industry among all the industries where the production has gone down from 1951 to 1958. This may be due to various reasons either the raw-material is not available in sufficient quantity or the new substitutes have been found out or the import of the jute cloth has increased. This index for iron and steel industry which is one of the important industry for the economic development, as it is the mother industry for all engineering concerns, has increased by 88% in

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1955 and 116% in 1958. This index for Starch has also increased much in comparison with most of the industries. This may be due to the increase in consumption of starch in Cotton textiles, Chemicals and washing companies. This index for Cement industry is 169 in 1955 and 194 in 1958 indicating the constant increase in the production due its increased demand in construction during the plan period.

Net output index:

This index for all industry total is 149 in 1955 and 144 in 1958. The gross output index has remained constant for these two years while this index decreases by 5% from 1955 to 1958. This indiactes that the cost of raw-materials, wages fuel, etc., might have gone up resulting the decrease in the net output. This index for bicycles and sewing machines is maximum because of the reasons we discussed above. Considering the industries in which the gross output index has increased but the net output index has decreased, this index for fruit and vegetable processing is 103 in 1955 and 90 in 1958. This index

TABLE I

Index Numbers of gross output, Net output, Capital and Man-hour for 1955 and 1958 (1951=100)

Sr. No.	*Industry*	*Gross output index*		*Net output index*		*Capital index*		*Man-hour index*	
		1955	1958	1955	1958	1955	1958	1955	1958
1.	Wheat Flour	201	225	273	312	164	180	130	138
2.	Rice Milling	244	212	425	235	196	164	176	143
3.	Biscuit making	104	135	106	134	134	121	72	74
4.	Fruit and Vegetable processing	103	125	103	90	111	90	94	92
5.	Sugar	134	127	160	160	156	170	112	110
6.	Distilleries and Breweries	162	171	167	168	111	100	89	93
7.	Starch	212	294	310	331	181	363	83	103

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8. Vegetable oils (excluding edible hydro. oils)	116	106	290	305	112	83	111	80
9. Vegetable oils (edible hydro. oils)	102	145	196	209	86	97	98	99
10. Paints and Varnishes	144	147	145	167	119	115	105	96
11. Soap	100	120	105	133	112	112	92	92
12. Tanning	134	92	129	116	141	106	106	86
13. Cement	169	194	190	167	197	325	91	130
14. Glass and Glassware	168	216	163	215	227	216	111	124
15. Ceramics	165	231	170	230	195	238	109	138
16. Plywood	206	182	204	187	216	225	164	157
17. Paper and Paperboard	180	252	189	235	165	256	118	149
18. Matches	129	136	127	162	158	136	136	112
19. Cotton textiles	125	104	140	104	131	139	111	106
20. Woollen textiles	126	139	105	132	139	144	104	121
21. Jute textiles	79	66	86	85	113	103	105	96
22. Chemicals	219	289	190	280	307	338	135	151
23. Aluminium, Copper and Brass	173	182	187	227	135	141	100	102
24. Iron and Steel	188	216	208	187	171	331	103	104
25. Bicycles	487	685	381	493	419	584	237	339
26. Sewing machines	287	522	268	493	220	306	163	218
27. Electric lamps	212	227	249	207	145	109	139	163
28. Electric fans	145	167	158	135	186	139	88	90
29. General and Electrical Engineering	174	232	168	221	160	191	109	129
All industry total	133	134	149	144	149	174	110	109

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TABLE 2

Productivity Index (Gross and Net Output, 1955=100) and Net Output Per Man-hour

Sr. No.	Industry	Productivity index (gross)		Productivity index (net)		Net output per man-hour in Rs.		
		1955	1958	1955	1958	1951	1955	1958
1.	Wheat Flour	155	163	210	225	1·30	2·73	2·92
2.	Rice Milling	139	148	241	163	0·49	1·18	0·80
3.	Biscuit making	145	116	147	181	1·29	1·89	2·33
4.	Fruit and Vegetable processing	110	93	109	98	2·04	2·23	1·99
5.	Sugar	119	99	142	145	1·42	2·02	2·06
6.	Distilleries and Breweries	182	184	187	180	1·25	2·34	2·25
7.	Starch	255	287	371	321	0·70	2·60	2·25
8.	Vegetable oils (excluding edible hydro. oils)	104	132	262	383	0·37	0·96	1·40
9.	Vegetable oils (edible hydro. oils)	105	147	201	210	2·00	4·02	4·20
10.	Paints and Varnishes	137	153	138	174	2·71	3·75	4·71
11.	Soap	108	131	114	145	4·70	5·34	6·82
12.	Tanning	126	108	121	136	0·66	0·80	0·90
13.	Cement	186	149	208	128	1·85	3·85	2·36
14.	Glass and Glassware	151	175	147	174	0·47	0·69	0·82
15.	Ceramics	151	168	156	167	0·61	0·95	1·02
16.	Plywood	126	115	125	190	1·10	1·38	1·31
17.	Paper and Paperboard	153	168	160	158	1·49	2·39	2·35
18.	Matches	95	122	93	144	1·33	1·24	1·92

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19.	Cotton textiles	113	98	127	99	0·98	1·24	0·97
20.	Woollen textiles	121	114	101	109	1·33	1·34	1·45
21.	Jute textiles	76	69	81	89	0·91	0·74	0·81
22.	Chemicals	162	191	141	185	1·99	2·80	3·68
23.	Aluminium, Copper and Brass	172	176	186	222	1·24	2·31	2·75
24.	Iron and Steel	182	207	202	180	1·69	3·41	3·04
25.	Bicycles	205	202	160	145	1·50	2·40	2·18
26.	Sewing machines	177	240	165	226	1·21	2·00	2·74
27.	Electric lamps	153	139	180	127	1·32	2·37	1·68
28.	Electric fans	165	185	180	149	1·08	1·94	1·61
29.	General and Electrical Engineering	160	179	155	132	0·99	1·53	1·71
All industry total		120	122	136	132	1·07	1·45	1·41

for cement industry has increased by 90% from 1951 to 1955 and decreased by 23% from 1955 to 1958 even though the gross output index has increased by 25% from 1955 to 1958. If we consider the capital index for this industry it has increased by 97% in 1955 and 225% in 1958. It may be concluded that the investment has increased much from 1955 to 1958 because of the demand of the commodity but the net output has not increased because we cannot have the return in the near future in a major industry like cement. This index for iorn and steel industry is 208 in 1955 and 187 in 1958, i.e., it decreases from 1955 to 1958 even though the gross output index increases from 1955 to 1958. The capital index for this industry is 171 in 1955 and 331 in 1958. The investment has increased much from 1955 to 1958 while the net output has decreased. The conclusion is the same that we said about Cement industry. This index for Sugar industry is 160 in 1955 and 1958. It has

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remained constant in both the years while the gross output index has decreased from 1955 to 1958. This is a good sign of progress for an industry as the net output which is an income concept has remained same even though the gross output has decreased. Same is the case for Vegetable oils (excluding edible hydrogenated oils). In Electric lamps and Electric fans, the gross output index has increased from 1955 to 1958 while the net output index has decreased during this period. This may be due to the increase in cost of manufacturing these items.

Capital index :

This index for all industry total is 149 in 1955 and 174 in 1958. This indicates that the capital investment has increased in the industrial sector during these plan years. This may be to expand the industries and to substitute the new automatic machines for old machines. The maximum index is that of bicycles and it is 419 in 1955 and 584 in 1958. The conclusion is the same that we discussed for its gross output index. If we consider major industries, this index for Cotton textiles as 131 in 1955 and 139 in 1958 even though the gross output and net output have decreased during these years. The reason may be that the capital must have been utilised to replace labour by introducing automatic machines. The capital investment has increased nearly three times in Iron and Steel and Cement industry. This may be due to the fact that cement and steel are the basic raw-materials for construction and are required for project constructions in plans. The increase is much more from 1955 to 1958 than that from 1951 to 1955. This may be due to the fact that more importance was given to the industrial sector in the second Five-year plan than that in the first Five-year plan. This index for chemicals is 307 in 1955 and 338 in 1958 indicating good increase in capital investment in chemical plants during these years. It has increased much from 1951 to 1955 but less from 1955 to 1958. One of the reasons may be that much importance was given to agriculture in the first Five-year plan. Hence the capital investment might have increased

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in chemical industry to produce various types or chemical manures to increase the production in agriculture. In vegetable oils, capital investment has decreased even though the output has increased during 1951–1958. This index for Jute textiles has increased even though the output has decreased. The reason may be the same as that of Cotton textiles.

Man-hour index :

The man-hour index for all industry total is 110 in 1955 and 109 in 1958, i.e., it has increased by 10% from 1951 to 1955 but remained nearly constant from 1955 to 1958. The employment opportunities in the industrial sector has not increased much. One of the reasons may be that the capital investment has increased to replace labour by introducing modern machines and hence the same worker can operate more number of machines. This index is maximum for bicycles for the reasons stated above. This index has decreased for Biscuit making, Fruit and Vegetable processing, Distilleries and Breweries, Vegetable oils, Soap, Electric fans, etc. Generally this index has decreased for minor industries. If we consider major industries, this index for Cotton textiles is 111 in 1955 and 106 in 1958. This index for Jute textiles has not decreased much even though the production has decreased, rather it has increased in 1955, (i.e. 105). In Cement industry this index is 91 in 1955 and 130 in 1958 even though the output has increased. For Iron and Steel industry, this index is 103 in 1955 and 104 in 1958 even the production has increased twice that of 1951. The capital for this industry has increased three times indicating the expansion of this industry. The man-hour index has not increased even though the industry has expanded much during the plan periods. From this we conclude that the recent trend in the industry is to replace labour by capital.

The index number of productivity (gross and net output) and net output per man-hour in terms of value in rupees as defined above has been calculated at constant prices for all 29 industries for 1955 and 1958 (1951=100) and are given in Table 2.

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Productivity index (Gross):

The study of Table 2 reveals that gross-productivity index for all industry total is 120 in 1955 and 122 in 1958, i.e., this productivity has increased by 20% from 1951–1955 and by 2% from 1955–1958. So the over-all productivity has increased much from 1951–1955 while it is nearly the same from 1955–1958. The increase in productivity is more in Starch, Bicycles, Sewing machines and Iron and Steel. These are all minor industries except Iron and Steel industry. If we consider major industries, the productivity index for Cotton textiles is 113 in 1955 and 98 in 1958., i.e., the productivity has decreased from 1955–1958 which is significant as it is supposed to increase because of modern machines and techniques. In Woolen textiles, this index is 121 in 1955 and 114 in 1958 indicating the decrease in productivity 1955–1958. The index for Jute textiles is 76 and 69 which is minimum among all the industries. This indicates that the productivity in Jute textiles has decreased very much. We have seen above that output also goes on decreasing for this industry. So this industry deteriorate every year instead of progressing because of planning. This index for Cement industry is 186 in 1955 and 149 in 1958, i.e., the productivity of this industry increases by 86% from 1951–1955 and decreases by 37% in the period 1955–1958 even though the capital investment increases much in this period. One of the reasons may be that new Cement factories might have started in this period and they might have not started the production in the beginning years and hence the output per man-hour may go down. The same thing is reflected if we consider the net output productivity index for this industry. This index for Iron and Steel industry is 182 in 1955 and 207 in 1958 indicating the increase in productivity from 1951 to 1958. But if we refer the net output productivity index for this industry it decreases from 1955 to 1958. Partially, the reason may be that we mentioned above for the Cement industry. Generally, the industries connected with Iron and Steel show more increase in productivity.

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Productivity index (net) :

This index for all industry total is 136 in 1955 and 132 in 1958. This indicates that the net output productivity decreases by 4% from 1955 to 1958. This index is more for wheat flour, Starch, Vegetable oils, Aluminium, Copper and Brass and Iron and Steel. If we consider Sugar industry, the gross productivity has decreased from 1955 to 1958 while net productivity has increased from 1955 to 1958 indicating the progress in the industry in the income sense. In the case of plywood the gross productivity decreases from 1955 to 1958 while net productivity increases much from 1955 to 1958. The reason may be that the input cost might have gone down relatively. In case of bicycles whose production has increased much, the net productivity index has decreased from 160 in 1955 to 145 in 1958. The reason may be the same as that of Plywood. Same is the case for Electric fans and General and Electrical Engineering.

Net output per man-hour :

This output is more for Soap, Paints and Varnishes, Vegetable oils (edible hydro. oils). Glass and glassware. The net output per man-hour is generally more for minor industries. Moreover, the net productivity increases for minor industries from 1951 to 1958. If we consider major industries, the net output per man-hour is about Re. 1·00 for Cotton textiles, Rs. 1·35 for Woolen textiles and about Re. 0·80 for Jute textiles. Net output for Cement industry, Iron and steel and chemicals is about Rs. 3·00 per man-hour. This indicates that the net output per man-hour in these two industries is maximum among the major industries. The average net output for all industry total is Rs. 1·31 per man-hour. The above analysis gives the idea of the change in output and productivity during the planning years 1951–1958. We can certainly say that the over all output and productivity has increased because of planning in India. The analysis gives the clear and detailed picture of all the industries during these years. The analysis is subject to the

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data available and it might have some draw backs but it does throw light on various aspects considered here.

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RELIGIOUS MOVEMENTS IN THE NINETEENTH CENTURY WITH SPECIAL REFERENCE TO GUJARAT

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"We Hindus", spoke Keshab Chandra Sen to the Bombay audience, "walk and sit religiously, eat and sleep religiously and work religiously". These words of a Nineteenth Century social reformer most appropriately described the social and religious frame work of Nineteenth Century India. The social institutions were very closely interwoven with religion, the caste system being one of the main strong holds of Hinduism. Gujarat was as much caste and sect ridden as the other parts of India. This is proved by Borradailes' census which shows not less than 212 castes and subcastes in Surat alone[1]. There were such numerous varieties of castes and sects and creeds in Gujarat that one sociologist was led to describe Gujarat as an "encyclopaedia of religions"[2]. For the same reason every social reform in the Nineteenth Century usually came through an appeal to the religion. The reformers carefully refrained from denying the 'authority' of the Hindu Shastras. They reinterpreted and sometimes even twisted the wordings of the religious precepts to suit the cause of social reform. At least in the first part of the Nineteenth Century the authority of the Hindu Shastras was unchallengeable.

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[1] This census was conducted by Borradaile in 1827. See Borradaile's *Gujarat Caste Rules*, Vol. II (Ed. by Sir Mangaldas Nathubhai, Bombay, 1887), pp. 1–4.

Govindbhai Hathibhai Desai ; *Hindu Families in Gujarat*, Baroda, 1932, pp. 36–37.

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However, if we analyse and compare the religious reform movements of the late Nineteenth Century with those of the earlier ones, we will notice a marked difference in the form and content of the two sets of religious movements. The later religious movements, influenced by the British rule, developed a broader outlook towards religion and society. They had a broader functional base. Partly this was also due to the reaction against the aggression of Christianity into the Indian soil. The religious movements of the early Nineteenth Century were comparatively more orthodox in nature. They were indiginous in the sense that they were totally uninfluenced by the western liberal ideas.

In the first half of the previous century several 'sampradayas' or religious sects emerged in Gujarat. However, we will take only the Swaminarayana sect as a subject of our study because this sect best represents the orthodox characteristics of the religious movements of the early Ninteenth Century. This sect was founded by Sahajanand Swami (1780–1830), a contemporary of Raja Rammohan Roi.

It is an interesting fact that the Swaminarayana sect itself emerged as a powerful protest against the current social and religious evils of those times. The eighteenth century is one of the darkest periods of Indian history. Indian cultural life in this century reached its lowest water-mark. The Mughal power after Aurangzeb's death in 1707 soon began to disintegrate and this was followed by the cut-throat competition among the Marathas, Nizam, Mughals, English and French to capture the political power in India. The chaos that prevailed in India and Gujarat was not merely political. Rather, it is true to say that the political conditions were a reflection of social and cultural degeneration of the people. Until the downfall of the Maratha power in 1818 there was almost a political vacuum in western India and each power was trying to fill the gap as best as it could.

The political instability in this part of the country made

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the people feel very insecure emotionally and economically. We have many instances of the Maratha incursions with all the adverse consequences on the economic and social life of Gujarat. Gujarat was the political battle field for the Peshwas, the English and Gaekwad. The political instability and economic insecurity greatly affected our social institutions which became more and more rigid. This was an era of religious superstitions, child marriage, caste regimentation, ban on widow remarriage and moral degeneration of the religious teachers. The Vallabhachari sect became corrupt under the impact of Vama Marga. It promoted all sorts of pleasures and sexual perversions. For example, it was a practice among some of the Vaishnav devotees to offer their wives and daughters for the pleasures of the head of the Vaishnav Church. This religious head was considered to be an incarnation of Lord Krishna.[3] This was the general political and social background of Gujarat when Sahajanand Swami started his sect in the beginning of the nineteenth century.

Now, as is already stated, the Swaminarayana sect originated as a reform movement. For this reason it protested against the current social and religious evils. The 'Sati Gita' written by Swami Muktanand around 1824 clearly throws light on the attitude of Swami Sahajanand and his sect towards the practice of Sati and female infanticide.[4] Besides discouraging these practices, the sect protested against the singing of obscene songs on marriage occasions and Holi festival. It also protested against the drinking habits among the 'lower caste' people. The moral preachings of the Swami and other leaders of the sect were aimed at simple and austere life of self-denial. But in spite of all its moral preachings against the current evils, the sect was still extremely orthodox. Unlike the later Arya Samaj and Prarthana Samaj, the Swaminarayana sect did not

[3] D. P. Thacker : '*Theistic Movements in Western India During the Nineteenth Century*' (N. M. Parmanand Prize Essay, Manuscript), 1937, p. 3.

[4] Swami Muktanand : *Sati Gita*, Manuscript Collection of Dalpatram Kavi, No. 411, Gujarat Vidyasabha, Ahmedabad, p. 17.

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liberalize and broaden the religious frame work. Instead, it made its religious superstructure extremely rigid by imposing strict regulations within its membership.

The Swaminarayana sect attracted the lower section of the people such as the Kanbis, Kachhias, Sonis, Darjis, Bhavsars and Suthars. But so far as the depressed classes — Bhangis and Dheds—were concerned, they were kept at arms length. They were debarred from entering the inner part of the temple, with the result that they built two temples of their own. Further as a divinely ordained institution, the Swami preserved the caste hierarchy in its purest form. He preserved caste distinction in its hierarchical order with the Brahmin at the top of the pyramid. Thus, the Swami asserted in his Shiksha patri:

"Nor shall any one drink in Jagannathpuri from a person of a caste lower than one's own, even though such food and drink be the remnants of the offerings to Shri Krishna."[5] Again:

"No one shall give up the performance of the duties that are imposed upon the class or the religious order to which he belongs, nor shall he adopt the duties that are enjoined on others, nor accept a religion propounded by heretical teacher."[6] In its attitude towards the problems of caste and untouchability, the sect, therefore, followed the traditional methods.

The Swaminarayana sect remained extremely intolerant towards even the normal relations between men and women. It is quite surprising that the sect which tried to save the life of a woman — by preaching against the practice of sati — encouraged a woman not only to worship her husband as her lord but also to suffer the insults and even the beatings of her husband. A chaste woman, states the Sati Gita, should give up all sorts of ornaments and decorations in the event of her husband's absence from the town or village.[7] Even the touch of a woman

[5] Manilal C. Parekh : *Shri Swaminarayana,* Rajkot, 1937, p. 327.

[6] *Ibid.*, p. 473.

[7] Swami Muktanand : *Sati Gita,* Manuscript Collection of Dalpatram Kavi, No. 411, Gujarat Vidyasabha, Ahmedabad, p. 17.

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was a sin to be atoned by a one-day fast. "One who belongs to our sect", said Swami Sahajanand, "shall...neither speak with a woman nor touch her. One who will not abide by these rules shall cease to be one of us".[8]

The women had, of course, their own organization within this sect. The 'religious minded' widows and other 'sadhavis' could preach a woman's group. But the women had a separate wing. No man was permitted to enter a woman's 'wing' and listen to the religious discourses from the mouth of a woman. "Males shall not listen to discourses on religious knowledge from the mouths of women, nor shall they carry on discussion with women, nor with a king or his officials."[9] And again:

"My male followers who are Grihasthis (house-holders) shall never touch widows unless they are their close relations. They shall not remain alone in any private place with a youthful mother, sister or daughter except in a time of distress, nor shall a wife be given away to another man."[10]

The sect opposed any reform in favour of widow remarriage. It was intolerant of a widows' freedom to marry. When the religious head or the Acharya of this sect visited Surat in 1849, Durgaram Mehtaji, a social reformer, asked him to preach in favour of widow remarriage. Both the Acharya and his associates turned red with rage and declared Durgaram an 'atheist' and 'infidel'.[11]

It will be seen from the above discussion of the Swaminarayana sect that like the other contemporary sects such as the Madhavagar Sampradaya at Nadiad, this sect, instead of liberalising its rigid framework, imposed more restrictions. Sahajanand Swami thought that he was introducing reforms in the contemporary religious and social life of the

[8] M. D. Kothari (Ed.): *Shreejini Prasadina Patro*, Ahmedabad, 1922, p. 3.

[9] M. D. Kothari: *Shiksha Patri*, Ahmedabad, 1925, p. 68.

[10] *Ibid.*, p. 69.

[11] *Bhuddhiprakash*, May, 1877, p. 117.

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people. In reality he was bringing back conservatism and reaction from the back door. As a 'religious' movement he could not possibly launch a crusade against the prevailing superstitions by appealing to reason. The drawback, however, is not that it did not appeal to reason. The drawback is that it failed even to reevaluate and reinterpret the Hindu Shastras in terms of the new conditions, such as was done by the later religious movements. It is in this respect that the major religious movements of the latter part of the Nineteenth Century differ from the early indigenous religious movements though they took place in the same century.

The end of the Maratha supremacy in 1818 started a new phase in the history of Gujarat. Gujarat now came under British subjugation. The impact of the western ideas began to be felt by this time. This was the age of reform in England and Britains' policies regarding its Indian administration was influenced by the utilitarian philosophy. By the middle of the Nineteenth Century India came under the direct influence of the utilitarians like Elphinston, Munro, Metcalfe, Macaulay, Bentinck and Dalhousie. The victory of Lord Macaulay in the 1830's solved one of the most controversial and intricate language issues—in favour of English language and western learning—which was to shape India's destiny in future. Railway and telegraph which were introduced during Dalhousie's administration (1848–1856) served as the integrating and unifying forces.

Thus the forces which shaped the growth of the religious movements in the latter half of the Nineteenth Century were unprecedented in Indian history. But this was not all. If this was a period of integrating process and material change, it was also the period of the onrush of Christian missionaries. The Charter Act of 1813 had given a free hand to the missionaries who started their activities with all the zeal of a religious fanatic. The great rebellion of 1857 was thus the result of the combination of material forces and proselytizing process on the part of the Christian missionaries. Thus if we

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look at the emergence of the Arya Samaj not as an independent religious reform movement, but mainly as a reaction and challenge against the rapid process of material change and religious conversion (of Hindus), we have a more rational explanation both of its origin and its later activities.

The Arya Samaj found the main source of its inspiration from the Vedas. Its founder, Dayanand Saraswati (1824–1883), had travelled widely in India and was pained to see the degenerated social order full of evil practices and superstitions. He saw the Christian missionaries taking full advantage of the situation, launching invectives against Hindu religion and converting Hindus with all sorts of tactics. Dayanand Saraswati was a great scholar of Sanskrit and well-versed in the Vedas and the Hindu religious classics. Yet his early childhood experiences had made him critical of Hinduism as it had prevailed in India since centuries after the end of the Vedic period. After terrific effort of historical imagination, the Swami came to the conclusion that there was nothing in this world more grand and sublime than Hinduism which prevailed in its purest form in the teachings of the Vedas. He thus discovered co-relation between the 'true' religion of the Vedas and the degenerated and corrupt practices which came to be followed in the latter times in the name of Hinduism.

In his effort to find a solution to the agonizing and painful situation, Dayanand found the salvation in the Vedas. In his effort to provide the lost identity—though, of course it was revivalism—to India, the Swami played a great role in the history of religious movements in India. The greatness of his role was in providing an image to India. Henceforward, Dayanand launched his religious reform movement in the name of the Vedas. His slogan "back to the Vedas" was to serve double purpose. It would, Dayanand thought, make India conscious of its grand age when she was not a slave of her religious superstitions but an advanced and prosperous country. It would also give a blow to the activities of the Christian

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missionaries. It would convince India that Hindu religion in its pure Vedic form was sublime and Christian religion was intolerant and illiberal.

The Arya Samaj opposed innumerable castes and sub-castes and creeds in which India was divided. It stood for equal rights for men and women in social and educational matters. It opposed infant marriages, ban on widow remarriages and untouchability. Vedic society, the Swami asserted, was free from all these evils. Caste differences were unknown to the Vedic people. The repudiation of the authority of the Brahmin, the danouncing of the infinite number of meaningless rites and the worship of images of different Gods and Goddesses which split the people into innumerable castes and subcastes — these were all the progressive elements in the programme of the Arya Samaj.

In so far as the Arya Samaj stood for equal rights for men and women, elemination of caste system, widow remarriage and such other reforms, it was certainly a progressive step. It was more democratic than the earlier Swaminarayana sect. Still, however, it remains true that with all its rich imagery and progressive elements, the Arya Samaj was orthodox and revivalist in essence. It was less liberal than either the Brahma Samaj of Bengal or the Prarthna Samaj of Bombay and Ahmedebad. The Arya Samaj came mainly as a reaction against the missionary activities to spread Christianity. It is doubtful whether, in the absence of the Christian fanaticism, Arya Samaj would have retained, its aggressive fervour or spiritual vigour. As it took all its inspiration from the Vedas in a perfectly unadulterated form, it had to declare the Vedas as infallible. Dayanand well knew that the Brahma Samaj of Ram Mohan Roi was influenced not only by the western foreign ideas but also to a certain exent by the principles of Christianity. He resented the foreign influences on Hinduism. Dayanand consciously avoided the foreign elements from his institution and declared Vedas as infallible. Thus the very logic of this thesis made it obligatory to appeal the people in the name of the authority of the Vedas

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and not to the reasoning capacity of man. To this extent, therefore, the Arya Samaj movement was authoritarian. Child marriages, according to this thesis, were to be abolished, not because they were mentally and biologically harmful to the couples but because they were not sanctioned by the Vedas. The castes and subcastes were to be abolished but at the same time the broad division of Hindu society into four divisions — Varnashram Dharma — was to be maintained because this was prescribed by the Vedic authority.

The Prarthna Samaj, on the other hand, was founded on the model of Brahma Samaj. The samaj was started in Bombay in 1867 and four years later (1871) it was started in Ahmedabad by the leaders of the social reform movement like Bholanath Sarabhai, Mahipatram Rupram and Ranchhodlal Chhotalal. Of the three leaders, the first two were the high Government officials and the third was the pioneer of the cotton textile industry in Gujarat. All these leaders had come under deep impact of the western liberal and individualistic ideas and participated in the reform activities in one way or the other. Mahipatram had gone to England as early as 1861 and raised the great issue of individual freedom versus caste authority.[12] The leaders of the Prarthna Samaj knew the singnificance and value of industrialization. They were quite consious of the moral and material progress which India was steadily making under the British rule. They were familiar with the works of J. S. Mill and Jermy Bentham, Edmund Burke and Lord Macaulay. It is for this reason that the Prarthna Samaj movement emerged as a middle-class, liberal and democratic movement.

It was quite natural that the Prarthna Samaj took its inspiration not from the authority of the Vedas but from the Brahma Samaj which aimed at the synthesis of ancient Indian culture and modern western thought. The first was authority oriented, the second was individualistic. It aimed at social reforms,

[12] For the detailed description of this event see my article in the *Journal of the Gujarat Research Society*, October, 1965, pp. 315–322.

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but its appeal was not to the Vedic authority but to the reason and common sense. The cardinal principle of the Prarthna Samaj was monotheism or the worship of God which had no form. It was a congregational worship in which people of all castes, sects and even race could freely unite in the common worship. Bholanath Sarabhai who "was the life and soul of the Samaj and the originator and prime mover", prepared the most enchanting and devotional hymns known as "Prarthna Mala".[13] The poems were completely free from any sectarian and communal idea.

Though Prarthna Samaj was mainly a religious organization, it extended its scope in the social sphere on account of its broad outlook. But so far as its programme of social reforms was concerned, the Prarthna Samaj appealed the people not in the name of the Vedas but in the name of humanism and better social order. In Gujarat it fought against child marriages, ban on widow-remarriages, ban on foreign travel, caste-dinners after death and Brahamanical authority. In the course of time the Samaj started a widows' home and orphan houses. More and more women started attending prayer meetings of the Samaj. By the year 1881, the Samaj became so popular that its branches were started in Nadiad, Kheda, Umreth, Petlad, Virsad, Sojitra, Baroda, Vaghodia, Brocah, Surat, Rander and Navsari.[14]

During the course of his missionary tours Dayanand Saraswati once came to Anmedabad in 1874. He met the leaders of the Prarthna Samaj and discussed with them many social and religious issues of the day. The Prarthna Samajists had great veneration for the Arya Samaj leader, but did not approve of his claim to the infallibity of the Vedas. Like Akbar's Din-I-Ilahi the Prarthna Samaj was broad enough to accept truth from any source, religious or secular, so long as it stood for humanitarianism. It never accepted any religious

[13] Krishnarao Bholanath : *Bholanath Sarabhainu Jeevan Charitra*, Bombay, 1888, p. 10.

[14] *Buddhiprakash*, 1881, p. 18.

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book as an infallible guide. Nor did it believe in divine revelation of any religious scriptures. For this reason, when Dayanand Saraswati proposed the Prarthna Samaj leaders to merge their institution with the Arya Samaj, they refused him to do so on the ground that they did not accept the Principle of infallibility.[15]

The forces which shaped the emergence of the Prarthna Samaj were representative of the new spirit of free inquiry and individualism. As such this institution remained free from the prejudices which shaped the organization of either the Swaminarayana sect or the Arya Samaj. The Prarthna Samaj had more civil or social character than the organizations described above.

The spirit of the new age of growing individual freedom against the religious authority was best manifested in the famous Maharaj Libel Case. It was no more accident that this significant event took place in Bombay in 1861, and which exposed before a wider public — on account of a printing press, a western institution—the ' sins ' of the Vaishnava religious heads.

15. *Krisnnarao Bholanath*, p. 118.

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APPROACHES TO THE STUDY OF SOCIAL CHANGE IN PSYCHOLOGY*

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We could hardly speak of any society as a static one. Every society is continuously confronted with changes of minor or major nature; some too frequently, others much less often; some on too many fronts, others in relatively very few directions. Social change, therefore, is a phenomenon that is of necessity, a part of the existence of every social group.

However, some groups or societies are too slow to change, and relatively so conservative that there are no substantial and noticeable signs of change in them; others show clearer manifestations of the influence of change. This has led to the use of a rather broad frame of reference of societies as traditional and advancing societies; or underdeveloped, developing and developed societies.

Particularly during the last few decades, several societies have been so rapidly and extensively affected by the phenomena of social change that students of different social disciplines have begun studying the phenomena, each from an angle appropriate to his discipline.

'Social change' is a sort of an all-inclusive term. Technological changes, changes in customs, behaviour modes, institutions, interpersonal relations, political matters, economic life, standards, values, ideologies—all are included in social change.

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Social changes are sometimes grouped into two types: material changes, such as those connected with technological advance, scientific achievements, modes of living, food, clothing; and non-material or relatively less tangible changes such as in values, ideas and ideologies, literature, inter-personal and social behaviour, customs, art, educational system and methods and so forth. This distinction cannot be pressed too hard, because, for example, changes in ideas of art and architecture are also reflected in the material shapes and forms and artistic representations of things.

Broadly, two kinds of interpretations have been offered regarding the causes of social change: unicasual interpretations as presented by Montesquiue, Malthus, Marx, Freud and others and multi-casual interpretations. All of the unicasual interpretations are based largely on speculative analysis and hypothesizing. For, discovering the independent factor or factors as causes of a given social change would demand controlled experimentation of a high order and isolation of the supposed cause or causes. By the very nature of things social phenomena are so intricately mixed up that they do not lend themselves to such rigorously controlled experimentation. Besides, in many cases, the student of social science can study the phenomena only retrospectively after the event. Even though in some cases, the unicasual hyhothesis has helped to cure some of the problems resulting from change, such as the Freudian and related hypothesis in psychology (in individual cases), there have also been failures. Social phenomena are complex and inextricably interrelated. It is even difficult to use the temporal sequence of *before* and *after* in analysing social change and its causation. What physically succeeds in time may have had prior influence in terms of ideas, ideologies, values, motivations, goals, aspirations, plans and so forth. And therefore analysis in terms of simple isolation of items on the analogy of, say, chemical or physical elements in the laboratory, is of no avail in social situations as far as available techniques of study are concerned. Statistical analysis has been used and is being used for obtaining more precise

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factoring of social situations and though it is very useful as far as it goes, there can still be doubts regarding the validity of the factors arrived at by statistical abstractions in the face of our inability in real life situations to isolate the phenomenon concerned, introduce and vary it under controlled conditions and observe and accurately record the effects. At the moment, therefore, there is a great weight of plausibility in favour of the multi-causal approach in the interpretation of social change.

From the psychological point of view, 'social change' has close relationship to an important area of study and practice, viz., 'personality adjustment'. However, the psychologist's study in this area is usually individual-centred, though recently there has been a tendency to study the problem from the point of view of groups. Yet, this, too, is more or less confined to groups of a small locality within a given country or nation and is neither a national nor a cross-cultural approach. Moreover, such studies are mainly concerned with offering psychotherapy to the mentally ill. It is only when the psychologist becomes also an anthropologist or associates with an anthropologist or *vice versa* that the problem of change is attacked countrywise or nation-wise by him.

Kurt Lewin was one of the first and most important psychologist to have attacked the problem of social change most systematically and by using experimental techniques as best as as possible.[1] The two most widely known concepts associated with Lewin's name, *group dynamics* and *action research* have both important relevance in the investigation of social change. He talked of changes in needs and valences.[2] In particular his and his associates' investigations on the "level of aspiration", "socially induced changes" and "social perception" are relevant in considering the problem of social change. His approach is generally referred to as the 'field theory' and is based on the gestalt psychology.

On the 'level of aspiration' several experimental investigations have been made. The level of aspiration has been defined "as the degree of difficulty of the goal toward which the person

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is striving".[3] The concept has relevance "only when there is a perceived range of difficulty in the attainment of possible goals and there is variation in valence among the goals along the range of difficulty". Lewin has tried to give it an apparently mathematical formulation, viz., the resultant valence of any level of difficulty.

= the sum of the valence of achieving success
× the subjective probability of success
− the valence of failure
× the subjective probability of failure.

The level of aspiration is in simple language, the goal an individual will undertake to achieve and so it will reflect the level of difficulty that has the highest resultant positive valence.

Studies on the subject have shown that a variety of influences affect the positive and negative valences of different levels of difficulty. Thus, it is pointed out that "cultural and group factors establish scales of reference which help to determine the relative attractiveness of different points along a difficulty continuum".[4] It is also pointed out that some of these influences are rather stable and permanent in their effects. For example, most westerners, dominated by cultural pressures toward 'self-improvement', when exposed to an experimental situation on the level of aspiration score initially a level of aspiration which is above a previous performance score and generally tend to keep their level of aspiration higher than their previous performance. Further, apart from cultural factors, the individual is influenced in his level of aspiration by the standards of his group.

Research has also shown that a main factor determining "the subjective probability of future success and failure is the past experience of the individual in regard to his ability to reach certain objectives".[5] Especially the last or most recent success or failure has a particularly great influence on the individual expectations of his future achievement level. Among other factors, the subjective probability scales, the performance

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of others and personality factors like self-confidence may also influence the subjects own probability scale.

It has been pointed out that the theory of level of aspiration shown its influence in many social phenomena. For example, the social apathy in the face of pressing political and international problems is explained by saying that people are not likely to attempt to achieve even highly valued objectives when they see no way of attaining them. Similarly social revolution tends to occur only after there has been a slight improvement in the situation of the oppressed group because the initial improvement raises their level of aspiration, for goals which were formerly viewed as unattainable are now viewed as possibilities.

It has been suggested that the concept of level of aspiration is helpful in comparing different cultures in regard to their system of values, such as need for achievement or success, fear of failure, optimism and pessimism and so forth.

Group dynamics distinguishes between changes due to forces which are imposed upon the individual and called *socially induced changes* and changes which are directly due to the individual's *own needs*. This distinction between *own* and *induced* forces is used in explaining several social situations. In particular, for example, it explains why workers both enjoy work and also are more productive when they are allowed to *participate* in the decisions concerning their work. Such participation creates self-motivating forces toward reaching the goal so that there is no necessity to use socially induced forces in the direction of work goal or restraining forces to prevent the individual from avoiding work.

In this connection, the concept of *powerfield* has also been used. A *powerfield* is a field which can induce changes in what Lewin calls "the life space" within its area of influence. The source of a *powerfield* may be a person, a group, a personal or a group value, a law, and so forth.

To my knowledge, the foregoing and other related Lewinian concepts have not yet been employed in a systematic

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cross-cultural study of developing countries to study resistance, acceptance, assimilation, modification, rejection of modes of technology, newly emerging needs and their awareness, new areas of human relationships, conflicts, tension, and so forth.

Barnett has made a study of cultural and social change in terms of innovation, from the anthropological and psychological point of view.[6] He argues that the problem of cultural change cannot be understood except by a socio-psychological approach. "No matter how this problem is viewed, it takes on an ultimate mental reference".[7] In all instances of innovation and change, eventhough quantitative changes are necessarily involved and are the ones that draw the attention of the observer at first, those changes are not the critical factor. "The definitive characteristic of a novelty is its newness with respect to the inter-relationships of its parts, not their number. Irrespective of whether or not quantitative changes are entailed, all innovations are qualitative departures from habitual patterns."[8] "Innovation, then", he asserts, "must be subject to the rules of thinking and feeling and any theory of invention must take this fact into account. In fact, such a theory should be a formulation of the rules of thinking as they pertain to the origins of new combinations of thought. This is at once a psychical (he obviously means 'psychological') and a cultural phenomenon, because the content of a thought predisposes the part it will play with respect to others. Its custom-determined substance will determine just which one of the possible mental reaction patterns it will provoke. Understood in this way, there can be no legitimate distinction between the psychological and the cultural approaches to the problen of cultural change."[9]

In all problems of social change, it is now gradually being recognized that the system of value-assumptions of a people plays a fundamental motivating part. Serious empirical studies in this area on cross-cultural frontiers in psychology seem to have begun with Gillespie and Allport's study entitled *Youth's Outlook on the Future* (1955).[10] followed soon by Charles Merris'

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study *Varieties of Human Value* (1956)[11]. The realm of values was till recent times considered to be the concern of metaphysics and moral philosophy, but judging from the current research it has now well-nigh become a part of psychological and anthropological studies, especially on the side of empirical research. (The same is true, more or less, of the problem of semantics.)

McClelland's important study in this area, *The Achieving Society*[12] makes an attempt to examine the psychological factors responsible for economic development and is related to the value approach we have referred. He particularly examines the role of the motive for achievement, or the need for achievement (*n*-Achievement), in economic growth and decline. He discredits the simple elementary notion that rapid economic development is hampered by high population density or high reproduction rate which on the surface appear to be the logical causes, yet actually are found to be not necessarily so in his empirical studies with evidence drawn from the ancient Greece, England from 1400 to 1800 and actual *n*-Achievement data collected from some 40 contemporary nations. He concludes that basically the level of *n*-Achievement is responsible for the pace of economic and technological progress of a nation. Amongst the sources of *n*-Achievement he mentions the following :

"Early mastery training promotes high *n*-Achievement provided it does not reflect generalized restrictiveness, authoritarianism or 'rejection' by the parents"[13]. However, the parent's expectation that his or her son should make decisions for himself may be due to the desire to promote self-reliance and mastery on his part, or a desire that the boy should not be a burden or trouble to his parents. If it is the latter, the boy will not develop higher *n*-Achievement. McClelland concludes that mothers of sons with higher *n*-Achievement hold out higher expectations of success for their sons in the occupational area, show them more warmth and less authoritarianism and

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restrictiveness.[14] Among the extremes that do not develop *n*-Achievement he mentions father dominance leading to development of low self-reliance in the son and therefore low *n*-Achievement, low standards of excellence and an indulgent attitude towards the son, too early achievement demands so that "the son is, so to speak, thrust out of the nest before he is ready to fly."[15]

Motivational effects of physiological, historical, political, economic and other external environments seem to be on a superficial observation easily connected with the society's progress " But these daily events—even major ones like wars—do not directly shape 'the tidal waves of history', but only indirectly as they affect the minds of men, or more specifically the values and practices of parents who are rearing the next generation. In terms of conscious policy, a nation may believe that it has accomplished something and most of its adult citizen may act in terms of such a belief, yet such beliefs and action may have effects on the motivation and values of the next generation which may undermine or change the very things they thought they had accomplished. "[16]

In a later paper he presents the results of a brief study of the levels of concern for achievement, affiliation and power in three key countries in South-East Asia : India, Pakistan and China (mainland).[17] The study is based on an analysis of 21 stories selected at random from children's readers in each of the three countries and coded by a highly objective scoring system for the three needs and the results were compared with similar data from the countries in his earlier study. The results showed an increase in the level of *n*-Achievement, low concern for *n*-Affiliation and high concern for *n*-Power in each of these countries, which is also actually reflected in their rapid development. McClelland finally reinforces his contention that it is values, motives or psychological forces that ultimately determine the rate of economic and social development.[18]

The superficial view that men's ideas and beliefs are responses to the conditioning forces of institutions and ideas

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is erroneous. And therefore, if one wants to bring about real social change he must seriously attempt changes in the basic ideas and values rather than superficially work on changes in the environment hoping thereby to effect true changes in the society. "Ideas which have succeeded in capturing the minds of men shape institutions which in turn change the material environment....increasing the *n*-Achievement level by half a standard score unit....would be more effective in promoting economic growth than tons of guns or butter."[19]

A recent contribution on the subject is by the economist Hagen based on an interdisciplinary approach to the theory of social change.[20] He finds that purely economic theories of lack of progress of nations are inadequate—such as the theory of low income lack of inducement to investment because of low income, inability to have highly costly transport facilities, power plants and so fourth. Empirical studies have shown that these supposed conditions and requirements do not exist in fact or are not of great importance.[21] Similarly, difference in degree of contact with the West also fails to explain lag in development. Indonesia, India, China and Japan have had contacts with West in decreasing order, yet in their development, the order is reverse with Japan leading.

Hagen stresses the need for "system analysis" in social phenomena as an increasingly fruitful method. This involves breaking down the system into simple measureable ones and noting the *functional relationships* among them. The important point to note here is 'the functional relationships'. So far the behavioural sciences have been largely descriptive and therefore do not contribute adequately to our understanding of social phenomena. System analysis is advocated while realising the fact that the subject-matter of social phenomena is complex, for "students of any field of knowledge cannot formulate an analytical model until, as their understanding grows, their images of the phenomena begins to resemble elements connected by functional relationships."

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Hagen also emphasizes that "a sound theory of personality must be an important component of system analysis in the study of societies, for the analysis of societies is analysis of human behaviour and such analysis which omits the clues provided by current personality theory is unnecessarily crippled".[22] While accepting the possible contribution of the disciplines of anthropology, sociology and psychology[23] to each other in such an integrated study, Hagen feels that "it seems likely that the major flow of benefit will be from psychology to the other two disciplines".[24]

Influenced by Erikson's work *Childhood and Society* and discussions with him, Hagen goes on to note briefly the nature of the functional relationships between elements of social structure and elements of personality which need to be introduced into models of society for understanding the phenomena of social change.

In explaining his theory of influence of childhood on society, Erikson has given particular attention to social reformers such as Martin Luther. The reformer has learnt in his childhood satisfactory pattern of solution of a personal problem that caused him severe anxiety, for example, the tyranny of an arbitrary father. In his adulthood, when faced with the problem, for example, of authority abusing its power, he reacts in the way he had learnt to react in his childhood against parental tyranny. Such a reformer is than joined by other individuals who also feel tyrannized by the oppression of the authority and thus they accept him as their leader, which leads him on to accomplish a great social change.

Hagen extends this method of interpretation to all men, and not merely the reformers, to illustrate the thesis that childhood experiences which mould the personality structure of all or most individuals of a given group at large more or less in similar ways owing to common customs, traditions and family and environment will determine their reaction to any social situation as adult human beings of a society also in more or less similar ways leading even to revolutions.[25]

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"A relationship between childhood and adulthood somewhat like that in the lives of reformers exists for all men The tenor of any age is powerfully influenced by the pattern of relationships which the members of a society have found satisfactory as children. If a hierarchical authoritarian social structure persists for centuries (as it has in traditional societies), it must be concluded that the members of the society found it satisfactory and did so because in childhood they found such a structure of relationships the best solution to a problem they faced."

Hagen accepts that personality is not fully developed in childhood and that it changes throughout life and the relationship between childhood and adulthood is very complex.

"The motivations of the adult which lead him to seek a pattern of relationships paralleling those which were satisfying in his childhood are of course unconscious. Perhaps no other single step in the broadening of their analytical tools will increase the power of sociology and anthropology as much as to incorporate in their analysis of human behaviour informed analysis of unconscious processes."[26]

Hagen also wants us to recognize the converse relationship between society and childhood.[27] "If changes in childhood environment are required before there can be any basic change in a society, it is also true that something must have caused the changes in childhood environment. And the most likely cause of change in childhood environment in a society which has hitherto been reasonably satisfying to its members (so that one generation has repeated the one before) is the appearance of some new tension in the social structure."

Hagen stresses the importance of innovation, or as he calls it, "creative innovation" in economic growth—and this is also true of all social growth and changes. He defines innovation as arriving at a new mental concept and giving it reality in the world outside the mind. It involves "problem-solving ability and a tendency to use it."[28] Innovation is of

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the essence of technological progress. It is sometimes said that the developing countries can achieve technological progress by simply immitating the advanced countries; they need not possess creativity. Hagen effectively argues that this is untrue. Creative innovation is required for technological progress in any traditional society as much as it was in existence in those advanced societies where technological progress began and made rapid progress.

There are cultural, social and technical reasons for this. Straightforward immitation of western methods is never possible. There are conspicuous individual differences and group differences in the characteristics of the labour force in the developed and the developing countries. (There are also similar differences in the management and managerial group.) Again, the economy of an advanced nation is a *technical and cultural complex*, not a collective set of isolated items of technology. The technological borrowings have to be readapted and fitted to the existing cultural conditions of the developing country. And innovation is necessary to do this. Finally, adaptation of all western methods may not be equally efficient for the developing economy as a whole.

Hagen further notes that the innovations required are not merely in the techno-economic field but also in the social field. For, techno-economic changes create forces resulting in major, political and social changes in fact in all aspects of human behaviour.

Along with widespread creativity in the sense of problem-solving ability as a prerequisite for economic growth, there is another important requirement, viz., "attitudes toward manual-technical labour and the physical world such that the creative energies are channeled into innovation in the technology of production rather than in the technology of art, philosophy, politics or other fields." Hagen believes that a study of the forces which change these two aspects of personality would yield substantial contribution to a good theory of social change.[29] In the traditional societies many elite individuals

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show a repugnance to do manual work, to "getting their hands dirty" and this repugnance is extended to attending to the details of running a business. This repugnance may be conscious, but often it may also be unconscious.

Intelligence is an important potent force that facilitates creativity. According to available evidence there is no difference on an average in its distribution in varying degrees in traditional and in non-traditional societies. Therefore the crucial difference affecting economic growth must lie in the basic attitudes. The central characteristics of creativity are high need for achievement, for antonomy, for order "and a sense of the phenomena about one as forming a system which is conceptually comprehensible, rather than merely being arbitrary external bundles".[30]

This is another way of saying that the value-system, or that part of the system which relates to forces facilitating techno-economic progress is the more determining factor in the techno-economic development of a nation.

And this is further stressed by Ayal's comparative study of Japan and Thailand.[31] The two countries have many similarities such as in their history, contacts with the Western world and also in other factors which are supposed to be important for economic development. But their value systems show very significant differences particularly in those propensities[32] which are related to economic development. The propensities chosen for study by Ayal were: "to accumulate capital, to work systematically and diligently, to cooperate in organizing effort in pursuance of goals and to innovate." The Japanese value-system laid high emphasis on activism in fulfilment of obligations of class status and loyalty, asceticism and frugality, development of expertise in carrying out one's tasks and diligence in performing these tasks.[33] In contrast, the Thai value system centers around personal values as opposed to obligations to institutions or other persons, based on the Buddhistic belief in reincarnation and in *karma* and that the individual is responsible for working out his own *karma*.[34] All this, including the Western-educated ones, show concern with acquiring 'merit' in

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order to improve *karma*. If someone achieves a high status, it is because his *karma* in the past birth had better merit and so he deserves it, though there are no formal barriers to status mobility in Thailand. Ayal concludes that development programs which do not also provide for changes in value system, when such changes are required, are bound to meet with failure.

Hagen has employed psychoanalytic concepts in the interpretation of social change in contrast with the field theory approach of Lewin and his followers. The following points may now be noted in regard to the field theory or the group dynamic approach on the one hand and the psychoanalytic approach on the other.

Broadly speaking, the group dynamic approach is concerned with the dynamics of the *present* behaviour. It tries to analyze and understand the present 'psychological field' of the individual, or of the individuals in a group situation—their present needs, goals, conflicts, tensions, etc. Though it is generally recognized that the individual's past has been in many ways responsible for his present needs and goals, his past is not considered to be crucial importance in investigating his behaviour now, particularly because the individual's past history is not the same as his memory of that past history, while his present memory and the present psychological effects of the past are the significant components of his present psychological field. It is these latter that can give true clues to his present behaviour according to the field theory. In contrast, as is well known, the psychoanalytic approach entirely depends upon the remote past of the individual and its traces on the unconscious to understand his present behaviour.

This, of course, is a rough and ready contrast between the two approaches. While the psychoanalysts hardly pay any attention to the present to discover man's basic motivation, the group dynamicists do not suggest that the past is to be disregarded, but that, in any case, it is already living in the living psychological present in some way and therefore need not be specifically attended to by tracing it in its details of long past.

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Several researchers have recently contributed papers on psychocultural factors in Asian economic growth in a special issue of the SPSSI[35] and we have already referred to some of the papers above. To those of you who may not be particularly familiar with the current trends in psychology, we may add the following: There have been all along two somewhat divergent outlooks prevalent in psychology, one which is looked upon generally as speculative, like psycho-analysis, or Roger's, Allport's and Maslow's approaches, depending less upon controlled experimentation, mathematical aids and more upon clinical observation (which really often leads into a kind of empirical study though this is not acknowledged by the other group) and the other, generally called the neo-behavioristic approach, such as Hull's, Skinner's, Guthrie's and others and considered by those who follow the approach as the 'scientific' approach. In the symposium mentioned above, Kunkel has undertaken the task of making a critical analysis of Hagen's theory from the latter approach. The theory, in his view, is based on un-scientific foundations because it uses concepts which refer to 'internal states' which cannot be empirically observed and studied as such, nor can they be validated, and therefore are hypothetical, rely upon inference or intuition of the observer. On the contrary, Kunkel suggests that 'an operant conditioning approach' adapting Skinner's and Sidman's suggestions, employing the reinforcement schedules, studying specific behaviour chains, etc., which than could be tested in different situations in order to determine the validity of behavioral generalizations would yield scientific conclusion. Kunkel then proceeds to reinterpret McClelland's data which he finds to be consistent with hypotheses derived from operant conditioning orientation. For example, among the Vicos Indians, by simply changing several reinforcing aversive stimuli, the Cornell group under Holmberg changed their activities and *also* changed their attitude and philosophy of life. No attempt was made to change their values or philosophy of life directly "The behaviour of peasants was altered by the ending of exploitation, the introduction of better crops, the instituting of cash wages, and by involving villagers

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in activities benefitial to them, as in building a school and running the hacienda affairs. The Indian values and philosophy of life apparently changed as a result of the changes they experienced in everyday life; the peasants became astate producers of potatoes and far-sighted business-men, for example, as soon as they realised that they were no longer under the rule of a capricious, self-centered patron, but responsible for their own welfare."[36]

It seems to me that for quite some time to come, until the neo-behaviorists are able to devise tools which are basically and truly scientific, quantitatively precise and capable of isolating cause-and-effect phenomena in behaviour and especially in group behaviour, the psycho-analytic and similar concepts and related tools such as projective techniques which provide plausible hypothetical constructs are going to be used by psychologists and anthropologists studying cross-culturally. These concepts and tools, however, could also be used with an eye to scientific rigour as far as this is possible in the present conditions, as McClelland has done, for instance. It may also be noted that despite Kunkel's general view (though he has not explicitly stated so) that psycho-analytic concepts are invalid, there have been important experimental studies which have now validated several of them with or without modifications. And after all, the true test of validity of a hypothesis is how it works in actual situations. Measures suggested on the bases of psycho-analysis are not all failures many are successful, fully or partially. This test of validity other methods have yet to prove-despite their marshalling all mathematical formulae and rigorous experimental approach in form. This, however, is certainly not to deprecate the use of experimental and mathematical rigour in psycho-anthropological investigations when ever and wherever and as far as possible.

Recent experimental studies in the phenomena of perception pioneered by Adlebert Ames, Jr. have given rise to an approach which has been systematised under the title 'transactional psychology' or 'transactional approach in psychology',

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or sometimes also as 'functional psychology' and one of its leaders, Hadley Cantril[37] has been employing the perceptiveness gained by work in these studies to make cross-cultural investigations on different issues. It is not possible to go into the details of this fascinating approach, but only an all-too brief reference will be made to it here. Transactional psychologists have shown most dramatically and convincingly than ever before, using three-dimensional situations in life-like replications, that man's perceptions of events, things, persons and relationships are almost entirely based on his past experience. When he is faced with a problem-solving situation he recalls and averages in his mental operations (which is a process yet all too vaguely understood) the relatively more successful responses based on his past experience and brings to bear these notions to deal with and solve the present problems keeping in view also the future goals he wants to reach. If the present objective reality he is facing does not correspond to his past experiences and there is a conflict, he goes even to the most ridiculous and illogical extent of holding fast to the past experience and refuses to recognize the different reality even he examines it himself and actually finds it too different. A re-examination of the objects and relations may be repeatedly made by him to discover that he is in error, yet in actual immediate behaviour response he sticks to his original distorted perception again. 'Conviction', 'reason' and even 'facts' never guarantee by themselves correction of man's perceptions, and therefore, also of his behaviour which is in response to these perceptions. The theory seeks to take into account the totality of interacting forces in human behaviour not only of the past and of the present but also of the future (goal, purpose). And in this sense it is a 'transaction' and not just 'interaction'. It is easy to see that this view also takes a *functional* approach to understanding human behaviour.

This theory seems to explain admirably why 'traditional' societies are traditional or conservative, why they refuse to accept progressive notions and practices despite the

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objective and too obvious evidence of their success elsewhere, why even when they become enthusiastic to accept them they go on fumbling and unwittingly reverting back to the old wrong traditional ways, why they constantly feel out of gear though wanting to take on to the reformed ways, and why, even when they seem to have taken to 'progressive' or 'advanced' ways, these seem to touch them only on the surface while deep inside they still cling to the old traditional ideas. And this often makes *true* progress or change very difficult. (It is with reference to such basic fundamental motive forces that Mahatma Gandhi first used the telling phrase 'change of heart' and wrote that the many verbal professions by the ruling British Government of change in its outlook including even legislative measures were of no true significance until there was a 'change of heart'.)

Taking all these aspects into account, I am tempted to use the term 'psychological lag', on the analogy of Ogburn's well-known term, to denote the distance or the gap between the current rapid advances in technology and science on the one hand, and the psychological preparedness of the human group concerned to catch up with them in terms of needed behavioural adaptations in several directions without discomfort and even with enthusiasm and expectant receptivity.

Within the very short time in which I was to prepare the paper it was not possible to contact and to find out from Indian psycholgoists about their studies on the subject. To my knowledge no full-length psychological study has been made in India so far on the subject, but a few short studies come to my mind on change as it affects different aspects of social life in India.[38] Khatri's studies indicate the effects, among other things of conflict created by modern progressive ideas of individualism, more free inter-sex mixing, need to be independent and other new norms clashing with traditional notions and practices especially in the family and how this affects mental health in India. In a study, which is now outdated, on the effects of industrialization on workers coming to the city from rural areas[39] the following

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method was used among others together pertinent data : The workers were asked how *they think their folk at home* in the native villages would and do react to several aspects of urbanization. This kind of method was identified as the technique of "reciprocal empathy"[10], a process of putting oneself into the other fellow's 'psychological shoes', and its use in studies of techno-social change seems to have great potential value as projective, additive, as well as corrective auxiliary to data collected by other means of direct interrogation, analyses of current literature and myth and observation.

Notes

1. Lewin, K.: *Field Theory in Social Science*, N. Y., Harper, 1951. Quoted by Deutsch, Morton: "Field Theory in Social Psychology", Ch. V in Lindzey, Gardner (Ed.): *Hand-book fo Social Psychology*, Volume I, Cambridge Mass.: Addison-Wesley, 1954, p. 207 ff.
2. What attracts an individual or acts as incentive to him is said to have a *positive valence* for him; what repels him is said to have a *negative valence* for him. Valences naturally depend upon the person's pleasant or painful experience with the stimulus concerned.
3. Deutsch, Morton: *op. cit.*, p. 208 ff.
4. *ibid.*
5. *ibid.*
6. See Barnett, H. G. : *Innovation: The Basis of Cultural Change*, N. Y., McGraw-Hill, 1953.
7. *ibid.*, p. 15.
8. *ibid.*, p. 10.
9. *ibid.*, p. 16.
10. Gillespie, J. M. and Allport, G. W. : *Youth's Outlook on the Future*, N. Y., Doubleday, 1955.
11. Morris, Charles : *Varieties of Human Value*, Chicago-Ill, Chicago Uni., Press; 1956.

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12. McClelland, David C. : *The Achieving Society*, Princeton, N. J., Nostrand, 1961.
13. *ibid*, p. 345.
14. *ibid.*, pp. 353, 355.
15. *ibid.*, p. 356.
16. *ibid.*, pp. 387–388.
17. McClelland, David C. : "Motivational Patterns in South-East Asia with special reference to the Chinese case" in Nash and Chin (Eds.) cited below, p. 9.
18. *ibid.*, p. 18.
19. *ibid.*, p. 18.
20. Hagen, Everett, E. : *On the Theory of Social Change : How Economic Growth Begins.* A study from the centre for international studies, Massachusetts Institute of Technology, Homewood, Illinois, the Dorsey Press, 1962. Well-known as an economist, Hagen, when confronted with the problem of studying economic growth of developing countries, found that he could do his task effectively only if he also mastered the findings of psychology, anthropology and sociology. In addition, he took advice and also had research associates from these disciplines. See also his subsequent paper "How Economic Growth Begins : A Theory of Social Change", in Nash, M. and Chin, R. (Eds.) : *Psycho-Cultural Factors in Asian Econonic Growth*, J. Soc. Iss., Jan., 1963, xix, 1, 20–34.
21. Hagen (1963) : *op. cit.*, p. 20.
22. Hagen (1962) : *op. cit.*, p. 5.
23. Hagen thinks that political science should not be listed as a separate discipline in this context because "The newer school of political science integrates the three Social Sciences in the study of some aspects of Social behaviour...." Hagen, *op. cit.*, p. 4, foot note 1.
24. Perhaps his enthusiasm in favour of psychology may be due to the fact that Hagen has been very much more familiar for many years with economics and therefore it is

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relatively a case of "distance lends enchantment view", or because psychology has been his latest love and therefore, there may have been a forgiveable disregard to the claims of economics and sociology. Actually it is possible that there will be quite important and major benefit from each one of the disciplines to the other two such that it will be well-nigh impossible to isolate each one's claims for the amount of benefit contributed in the joint venture.

25. Hagen (1962) : *op. cit.*, pp. 6–7.

26. "The need to do this may be one of the barriers which has retarded the integration of the social sciences. It is difficult for many individuals, in the social sciences as elsewhere, to admit unconscious processes into their analysis, simply because many of one's own unconscious processes are painful and it is just as well to deny that they are of importance". Hagen's foot note in *ibid.*

27. *ibid.*, p. 7

28. Hagen (1963) : *op. cit.*, p 22.

29. Hagen (1963) : *op. cit.*, p. 22.

30. *ibid.*, pp. 24–25.

31. Ayal, Eliezer, B. : "Value Systems and Economic Development in Japan and Thailand", in Nash, M. and Chin, R. (Eds.) : *op. cit.*, pp. 35–51.

32. The term 'propensities', according to Ayal here, ' stands for internalized behavioristic and instrumental values, or predispositions to action, which have their origin in the value system", *op. cit.*, p. 39.

33. *op. cit.*, p. 41.

34. *op. cit.*, pp. 45–46.

35. Nash, Manning and Chin, Robert (Eds.) : *Psycho-Cultural Factors in Asian Economic Growth,* Sp. issue of the *J. of Social Issues,* Jan., 1963, XIX, 1. Contributions by Nash, McClelland, Hagen, Ayal, Bellah, Bradburn, Kunkel. SPSSI

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is the Society or the Psychological Study of Social Issues which is a Division of the American Psychological Association.

36. *See also* Adams, R. N. et al : *Social Change in Letin America today*, N. Y., Harper, 1960.

37. Centril, Hadley (with Buchanan, William) : *How Nations See Each Other*, Urbana : University of Illinois Press, 1963; *Understanding Man's Social Behaviour Preliminary Notes.* Princeton : Office of Public Opinion Research, 1947; The nature of Social perception. *Trans. N. Y. Asad. Sc.*, 1948, 10, 142–153; Toward a Scientific Morality, *J. of Psychol*, 1949, 27, 363–376; An Inquiry Concerning the Characteristics of Man. *J. Abn. Soc. Psychol.*, 1950, 45, 490–503; *The "Why" of Man's Experience*, N. Y., Macmillan, 1950; (with Ames, A., Jr.) : *Further Notes Toward an Understanding of Human Behaviour : Values, Choice and Action* (Inter-Office memo), Litho-printed, 1951; The Nature of Our Reality Worlds, *Ind. J. Psychol.*, Vol. XXXII, Parts I and II, 1957, 51–63; Effective Democratic Leadership : A Psychological Interpretation, *J. Indiv. Psychol.*, Vol. 14, Nov. 1958, 128–138; *The Politics of Despair*, New York, Basic books, 1958, 269 pp. (with Bumstead, Charles H.) : *Reflections on the Human Venture*, New York, New York University Press, 1960, 344 pp. (with Toch, H.) : "A Preliminary Inquiry into the Learning of Values" in *J. Edl. Psychol.*, 48, 3 (March 1957), 145–156 (with Kilpatrick, F. P.) : "Self-Anchoring Scaling; A Measure of Individual's Unique Reality Worlds" in *J. Indl. Psychol.*, 16, 2 (Nov. 1960) (with L. A. Free) : "Hopes and Fears for Self and Country", suppl. to the *American Behavioural Scientist*, vi, Suppl. Oct. 1962, No. 2; *Human Nature and Political Systems*, New Brunswick, N. J., Rutgers University Press, 1961; *The Self-Anchoring Scale and Human Concerns : Scientific American* (with Livingstone, W. K.) : The Concept of 'Transaction' in Psychology and Neurology, *J. Indiv. Psychol.*

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Free Lioyd, A. : *The International Orientation of Parliamentarians in India and Japan*, Princeton, N. J., Institute for International Social Research, August, 1958.

Though there are several others doing excellent research in transactional psychology, Centril's work is mentioned here as much of it is in cross-cultural area and so also is Fear's.

38. Khatri, A. A. : 'Social Change in the Hindu Family and its Possible Impact on Mental Health', *Vidya*, Journal of the Gujarat University, March, 1963; 'Socio-Cultural Factors in the Guidance of College Students', *Journal of Vocational and Educational Guidance*, Vol. 8, No. 1, August, 1961; 'Social Change in the Cast Hindu Family and its Possible Impact on Personality and Mental Health', *Sociological Bulletin*, March and September, 1962; "Family Relations and Extra-Familial Human Relations', An unpublished monograph; 'Changing Family and Personality of Caste Hindus', An unpublished paper.

Kuppuswamy, B. (1957): "A Study of Opinion Regarding Marriage and Divorce", Asia Publishing House, Bombay.

39. Prabhu, P. H. : *Social Effects of Urbanization*, completed in 1954, pub. in "Five Studies in Asia", UNESCO, 1956. A critique of this study by M. D. Morris appeared in the *Economic Weekly* of Bombay, July 6, 1957. The original author had sent a full rejoinder to this critique to the paper for publication, but the Editor used this prerogative and cut several portions of argument as well as fact from the rejoinder and published a truncated version. A mimeographed copy of the full rejoinder is availab'e from the author.

40. Rector, Rex : "Reciprocal Empathy : A Study of Student-Teacher Interaction" in *Proc. Oklahoma Acad. Sc.*, XXXIV, 1955, 175–77.

Parenthetically, it may be noted that the present author had made plans (in consultation with several others),

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when he was with the UNESCO in 1956, for a research project to study the Psycho-cultural factors affecting productivity of labour in the east, which was later also to be co-ordinated with similar studies in the West. The following based on a preliminary note on the subject may give an idea of what the project had intended to accomplish :

The project was a pilot study of the psycho-cultural factors which influence men at work in industries for the time being confined to India. Variables that influence productivity from within the factory, like good or bad management, supervision, machinery, working conditions, welfare amenities, incentive system, etc., and personal factors like intelligence, aptitudes and so forth were not included in the study but only the factors stemming from the peculiar socio-cultural, traditional and customary beliefs and practices, the type of social and familial structure, local or national conditions, and so forth, which act as barriers or facilitate work modes and practices which become necessary as a consequence of modern mechanization, industrialization and the introduction of the modern economic system in the countries of South-East Asia were included.

Some of the broad hypotheses stated at the outset in this connection were : The practices of work, the changes in the ways of behaviour and also in outlook, and the new sets of relationships which the industrial workers have to face constitute a challenge to their ability to effect changes in their traditional culture and patterns of behaviour. During the consequent series of adjustments they are called upon to make, some of these workers may offer resistance of varying degrees, whereas others may fall in line with the new trends with comparatively less difficulty, while still others may even feel excited about the prospects of change in favour of a new order and may be prepared to meet the new demands in advance. Also, such changes will take place at different levels; some more superficial changes may be easily

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acceptable after a few years of work in a factory, but others will affect the workers more profoundly; some may be specifically predominant in workers of high productivity, some in those of low productivity. An attempt was first required to ascertain which are the specific components of the culture (to which the workers belong) and which could be assumed as hypotheses, then to find out how far there are trends which alter and which do not when the city and the factory exercise their influence, and finally, to see which changes are typical in high productivity workers and which changes or lack of them are preponderant in workers of low productivity. This would show the cultural components which had influence in the process of change and those which are disappearing in workers of high and low productivity respectively and would help to locate the cultural components which help and those which hinder productivity.

A questionnaire-schedule to cover the components mentioned above was prepared, pretested and was duly revised for use in the main pilot studies in Bombay and Calcutta. The components on which attention was focussed for study included family affiliations, parents' attitudes towards the children, their ambition to change their status; attitudes to work including manual work, rest and leisure; caste, group, collective membership and similar affiliations, other groups within and outside the factory; influence of education-general technical, etc., notion of time and rhythm of living and working; attitude to money economy, acquisitiveness, competitiveness, savings, investment, consumption, attitude to economic security; notion of gains and profits and related attitudes, attitude to employers; attitude to production viewed socially, attitude to productivity generally, value attached to the concept of output and size; attitude to machinery and modernization generally, attitude to waste of material, time, energy, upkeep problems, adaptibility to modern technology; religious influence (beliefs and practices); health, food habits (traditional), difficulties in changing them; attitude to women as workers.

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This was, obviously, a very large bill to be undertaken for investigation, but it was to be carried through as best as possible. Most unfortunately, however, at the end of the period of one year during which this writer made all the basic preparations and got it going the institute which had loaned his services to the UNESCO did not find it possible to extend the loan period and so he had to return to the institute leaving unfinished the very interesting and valuable work he had embarked upon. It was afterwards completed by the UNESCO with several interruptions (*See Social and Cultural Factors Affecting Productivity of Industrial Workers in India*, Delhi, UNESCO, 1961). Subsequently, one of his Ph.D. student has undertaken a similar study in Ahmedabad, and his findings, will be soon available. He has used some projective tests in addition to a schedule in his study.

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A STUDY OF ADJUSTMENT PROBLEMS OF STUDENTS IN THE ARTS, SCIENCE AND COMMERCE COLLEGES IN THE CITY OF AHMEDABAD

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SUMMARY

The purpose of the present attempt was to study the nature and kind of problems faced by the college students in various Arts, Science and Commerce colleges located in the city of Ahmedabad. The data was mainly collected through questionnaire method.

The inventory was administered to a group 1,264 boys and girls of various colleges studying in Pre-University classes. Necessary statistical analysis and tabulations were done and conclusions were drawn.

Introduction

During this last decade, educationists, psychologists and social workers have realized the importance of systematically studying various aspects of student's life and the need for and extent of guidance to the youth.

Consequently efforts are now being made in this direction. The present project attempts to study the nature and kind of problems faced by college students in the city of Ahmedabad.

The problems faced by the student occupy his mind and not only hinder him from doing whatever he is supposed to do at the moment, but also sometimes it leads to serve indiscipline and in some cases even to antisocial manifestations. When the student's mind is seriously prooccupied with problems, the entire effort for reconstructing or educating him will be futile. To remedy this situation an institution or university must attempt to know the problems of students and should try to solve them through systematic and organised efforts.

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Importance

The present study will be helpful to the educationists, psychologists, social workers and those who constantly deal with younger people to understand the various problems of college students and also to some extent to determine their needs.

The study will show the importance, if any, of a guidance center and draw clues for its growth.

Further, it will enable the teacher to change or to modify his approach for an individual student or a group of students either in class-room situations or in other informal ones.

Method

Sample :

For the purpose of this study, the population was defined as students studying in beginning classes in Arts, Science and Commerce colleges located in the city of Ahmedabad. Out of twenty five such colleges only five colleges did not think it feasible to cooperate in the present project. The total student population was estimated to be about 7,722 for the year 1964–65.

The sample was drawn from the beginning classes on the assumption that the pre-university classes, immediately after the S S.C. Examination, require greater adjustment to an entirely new set-up in terms of total structure. There is a big gap between the two set-ups-one which is completed before joining the college and the other which is being entered. Generally, it may be assumed that during this preliminary period of adjustment, the student is more likely to face various kinds of problems such as he may not have faced before.

Originally, the data was obtained in respect of 1,264 boys and girls selected from various Arts, Science and Commerce colleges located in the city of Ahmedabad. The data of one hunderd and seventy students was discarded as it was either incompletely filled in or it did not contain general information regarding the student.

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Data :

Mainly, the data was collected through the questionnaire method. Some students were personally approached and were asked to write their present problems and a few others were interviewed and were encouraged to discuss their present problems. The original report contains some illustrative cases of free writings of problems of students.

Statistical Treatment of the data:

All the retained questionnaires were scord out individually and frequency of each item marked by boys and girls was calculated separately and collectively. Other necessary tabulations and calculations were done.

Description of the tool used

The students problems inventory (given in the original report) was carefully prepared on the basis of information collected from various sources such as free writing of the problems by the students themselves, interviewing students for discussing their problems and relevant literature on students problems. It is a self-administering inventory.

The inventory consists of 265 statements of different problems covering various aspects of student life. They have been classified into nine different areas. Some areas problems overlap considerably.

The scoring of the inventory is simple. An individual's score is the number of problems he has marked. At the end of the inventory, there is an open entry, where a student may write any other problems not included in the inventory but which bother him.

Main findings

The following are some of the broad observations, based on the specific sample and the particular approach used :

(1) The first five problems most frequently marked by entire group of college students in the total inventory were 'I

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want to improve my English (73%)', 'I am unable to do some thing good as desired (62%)', 'I am do not get necessary guidance for studies (55%)', 'I am worried about my future career (52%)' and 'My family runs short of money (50%)'.

(2) The first five problems most frequently marked in the total inventory by the entire boys group of students only were 'I want to improve my English (73%)', 'I am unable to do something good as desired (62%)', 'My parent/guardians do not ask my opinions in important family matters (60%)', 'I need a part-time job (54%)', 'I want to be liked by others (50%)' and 'I am bothered by the fact that hetro-sexual friendship is looked upon with suspicion (50%)'.

(3) The first five problems most frequently marked in the total inventory by the girls students only were 'I want to improve my English (69%)', 'I am unable to do something good as desired (60%)', 'My parents/guardians do not allow me to take my own decision (65%)', 'My parents/guardians put too many restrictions on me (51%)' and 'I am bothered by people who give their opinion thoghtlessly (50%)'.

(4) There were few more problems marked by some of the college students in various areas indicating possibly severe lack of adjustment such as 'I have myself (6%)', 'I was married at an early age (3%)', 'I do not have many friends (17%)', 'I want to rebel against society (8%)', 'My parents/guardians are conservative (10%), or suspicious (9%) or illiterate (9%)'.

(5) The commonly expressed concerns in different areas by the group of students were 'I am over/under weight (B-42% and G-35%)', 'I over sleep (B-36% and G-37%)', 'I am losing hair (B-8% and G-56%)', 'I am too tall/short (B-27% and G-30%)' and 'I have anemic condition (B-9% and G-29%)', 'I am afraid of committing mistakes (B-39% and G-47%)', 'I want to learn how to depend on myself (B-47% and G-32%)', 'I get nervous while talking with other people (B-51% and G-38%)', 'I need someone for proper help (B-45% and G-25%)', 'Family runs short of money

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(B-47 % and G-35 %)', 'I need work to help the family (B-50 % and G-41 %)', 'I want to earn enough money (B-49 % and G-31 %)', 'I experienced difficulty in fulfilling my basic needs of life (B-45 % and G-35 %)', 'I do not have enough money (B-46 % and G-37 %)', 'I want to be attractive to the opposite sex (B-45 % and G-12 %)', 'I am such haunted by thoughts of the opposite sex (B-39 % and G-20 %)', 'I am worried whether the parents will give consent for love marriage' (B-39 % and G-20 %)', 'I need sex knowledge (B-18 % and G-19 %)', 'I have to depend upon my parents / guardians in money matters (B-51 % and G-39 %)', 'I have too many family responsibilities (B-17 % and G-42 %)', 'I want many things which other people have (B-38 % and G-49 %)', 'I am bothered about people finding fault with me (B-30 % and G-19 %)', I do not know how to say 'No' without injuring others feelings (B-28 % and G-40 %)', I am afraid of examination (B-40 % and G-49)', 'I am unable to follow lectures in English (B-49 % and G-48 %)', 'I am worried about success in the examination (B-39 % and G-47 %)', 'I want to know how to select right kind of vocation (B-50 % and G-31 %)', 'I doubt whether I will get a job after completing my studies (B-50 % and G-31 %)', 'I need a job (B-40 % and G-28 %)', 'I want to know how to develop my character (B-48 % and G-40 %)' 'I am bothered by lack of morality in elderly people (B-41 % and G-42 %)', 'I am unable to marry out side my caste (B-32 % and G-42 %)', 'I am bothered by customs like dowery in marriage (B-18 % and G-34 %).

(6) It was observed that the total number of problems marked by boys gradually increases up to the age of 19 years and then decreases up to the age of 22 years but again increases. In the same way, in case of girls, it increases up to the age of 18 years and then decreases.

(7) Both the groups—boys and girls —have a large amount of problem load in the areas of Vocational (B-44·44 % and G-33·33 %), Economic and Material Facilities (B-37·25 % and (G-31·52 %) and Educational (B-30·78 % and G-29·06 %).

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while in the areas of family (B–08·27% and G–15·31%), the problems appear to be the least. In the areas of Friendship, Sex and Marriage (B–27·17% and G–28·09%), Social (B–25·00% and G–25·00) and Educational (B–30·78% and G–29·06%), both the groups have expressed equal amount of concern.

(8) There is no significant difference between the total number of problems marked by boys and girls. But there is a difference between the two groups regarding the nature and types of problems.

(9) It was observed that there is a significant difference between the total number of problems faced by the students under the faculties of Arts, Science and Commerce.

Limitations of the study

The sample could not be randemly selected because of the administrative difficulties raised by the various colleges from time to time. In this case, the questionnaire was administered to an available group.

The study represents the problems which were faced by students at a particular time. The problems may change with time and from one situation to another. To take one simple, example, all examinations in India are at present based on essay type questions given for a brief period at the end of a two-year period of study. The examination system is likely to change to objective type evaluation and its frequency may change from once in two year to once in a fortnight. When this reform would have been introduced problems of students so far as they relate to study, etc., would materially differ. Further, varying types and amounts of contacts of the students with their teachers due to reforms like the introduction of tutorials, etc., will also affect the quality and types of problems of the student.

The problems studies in the inquiry are problems as perceived and felt by students. Hence it is obvious that a particular problem or problems discussed herein may not appear to be so to others.

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Implications of the study

The findings of the present study will help educationists, psychologists, social workers, parents and community at large to understand the needs of the youth.

It will necessarily help the people concerned with changing or modifying their dealings with students either individually or collectively in formal situations or otherwise.

Some of the findings suggest the need for establishing and developing student personnel services.

Suggestions

In the present study, it was possible to study only different kinds of problems faced by the college students. A further, attempt could be made to study causative aspects of these problems. Use of different methods could succeed in revealing even some of the deeper causes.

A further inquiry could be undertaken to study the nature and types of problems faced by students of different socio-cultural and socio-economic strata and of various educational levels, etc.

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STUDIES IN SOME VARITIES OF TOBACCO, PART III*[1, 2]

(Preparations of Nicotinic acid)

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Nicotinic acid has been the most studied of the pyridine acids because of its function as a Vitamin in human metabolism. In 1911 Funk[3] and Suzuki[4] isolated nicotinic acid from rice polishing and Elvehjem Madden Strong and Wolly[5] showed nicotinic acid to be a cure for black-tongue in dogs. Immediatly following this work nicotinic acid was successfully applied in treatment of Pellagra in human beings. This initiated an intensive research for adequate source of nicotinic acid. In 1940 about 10,000 lbs. of this acid has been manufactured for the treatment of pellagra. Considering the medical requirements for several pharmaceutical uses, it has been recently estimated that the total annual requirements for nicotinic acid approximates to about 60,000 lbs. This unprecedented demand stimulated research on variety of starting materials from which nicotinic acid can be prepared. Since nicotine has been the best known material compared to B–picoline, quinoline and pyridine, the nicotine which has been extracted from tobacco has been taken up for the conversion of nicotine to nicotinic acid.

Nicotinic acid could be oxidised from nicotine by a number of ways :

Oxidation by (*i*) nitric acid, (*ii*) potassium permanganate, (*iii*) potassium dichromate, (*iv*) hydrogen peroxide, and (*v*) bromine, out of these five methods, the last three methods have been found to be very economical as well as easy for manipulation.

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(a) Nicotinic acid from Nicotine (obtained from tobacco dust) preparation :

Nitric acid (d, 1·42; 190 g.) was taken in three-necked flask kept at 5°, to this is added nicotine (95%; 10 g.) with constant stirring the temperature was slowly raised to room temperature for two hours and then to 80° for another two hours with constant stirring. The contents were then heated on water-bath in hood and evaporated to dryness. The residual nicotinic acid nitrate was decolourised and recrystallised from water, as white crystals. The pure acidnitrate was boiled for 5 min. with distilled water and disodium hydrogen phosphate (14 g.), when nicotinic acid is crystallised out, filtered, washed and dried. The results are tabulated in Table I.

TABLE I

Yield of nicotinic acid in the oxidation of nicotine

Lot No.	*Wt. of nicotine in gms.*	*Wt. of nitric acidin gms.*	*Wt. of nicotinic acid nitrate in gms.*	*Wt. of nicotinic acid in gms.*	*m.p. of nicotinic acid*
1.	10·0 g.	190·0 g.	8·40 g.	3·25 g.	218°
2.	10·0 g.	190·0 g.	8·40 g.	3·50 g.	220°
3.	10·0 g.	190·0 g.	7·70 g.	3·50 g.	215°
4.	10·0 g.	190·0 g.	8·60 g.	3·20 g.	220°
5.	10·0 g.	190·0 g.	8·80 g.	3·70 g.	222°

In the above experiments varying temperature, time of stirring, using fuming nitric acid instead of conc. nitric acid, using 100% nicotine have been taken into consideration, wherein the conclusion has been arrived that (*a*) product of 100% purity of nicotine gives no better results than 95% nicotine, (*b*) fuming nitric acid does not give better results, (*c*) while the addition of nitric acid, the temperature must be between 0° to 5°, (*d*) the evolution of the fumes of oxides of nitrogen can be stored and utilised to minimise the cost.

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(b) Oxidation of nicotine to nicotinic acid by $KMnO_4$[6]

To Potassium permanganate solution (25%; 75 c.c.) and potassium hydroxide was added nicotine slowly with constant stirring, the temperature was raised to 75–85°. The mixture was kept for 4 hours with constant stirring. The contents of the flask are filtered, concentrated to half the bulk and acidified. The acidified solution was treated with sodium hydrogen phosphate and transferred to an evaporating dish for dryness. The residue is treated with barium hydroxide solution and on acidification, nicotinic acid is separated, filtered, washed and dried. The results are tabulated in Table II.

TABLE II

Yield of nicotinic acid by potassium permanganate method

Lot No.	*Wt. of nicotine*	*Wt. of Pot. permanganate*	*Wt. of nicotinic acid*	*M.P. of nicotinic acid*
1.	10·0 g.	90·0 g.	4·5 g.	220°
2,	10·0 g.	95·0 g.	4·6 g.	226–228°
3.	10·0 g.	100·0 g.	4·7 g.	215°
4.	10·0 g.	105·0 g.	5·1 g.	228°
5.	10·0 g.	110·0 g.	5·1 g.	227°

(c) Oxidation of nicotine by bromine :

This reaction has been previously studied by several investigators [7, 8, 9] who obtained resinous products and were not successful, later Piner[10] concluded that there is formation of dibromo-cotinine. To the nicotine in the flask was slowly added bromine in acetic acid with constant stirring at 50°, the sulphurous acid was passed through and the contents were poured in ice-cold water. Dibromo–cotinine crystallised out from dilute alcohol, m.p. 125 f. The second bromode rivative, dibromoticonine when heated in a sealed tube at 100° with barium hydroxide is decomposed into methylamine, nicotinic acid and malonic acid. The nicotinic acid is recovered and malonic acid is estimated.

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Yield of nicotinic acid

TABLE III

Oxidation of nicotine by bromine

Lot No.	*Quantity of bromine*	*Dibromoticonine*	*Nicotinic acid*	*Malonic acid (approx.)*
1.	50·0 g.	4·25 g.	1·90 g.	1·20 g.
2.	60·0 g.	4·52 g.	2·10 g.	1·60 g.
3.	70·0 g.	4·69 g.	2·20 g.	1·70 g.
4.	80·0 g.	4·90 g.	2·40 g.	1·75 g.
5.	90·0 g.	5·05 g.	2·45 g.	1·80 g.
6.	100·0 g.	5·10 g.	2·50 g.	1·82 g.
7.	110·0 g.	5·30 g.	2·52 g.	1·85 g.

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EXTRACTION OF BRUCINE AND STRYCHNINE FROM NUX VOMICA AVAILABLE FROM MARKET AND TO STUDY THE EXTRACT POLARIMETRICALLY

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Strychnine and Brucine have been long used as antidotes for poisioning by, or accidental overdosage of central nervous system depressants. They are used as bitter tonic, adjunct to laxatives, circulatory stimulant in shock, treatment of myocarditis and delirium tremens. These are the main constituents of the good quality of Nux Vomica (dried ripe seeds of Strychnos nux vomica) together with a very small quantity of other alkaloids of minor importance.

The total percentage of alkaloids ranges from 2·5 to 3 per cent, about one half of which is Strychnine and the rest mainly brucine. As the proportion is variable, the ratio of strychnine to brucine content is generally between the range of 1 : 1 to 1 : 1·2. The most important drug constitutent of nux vomica is strychnine, which is forty times more potent then brucine. The strychnine is mainly determined from nux vomica by British Pharmacopea method, spectrophotometric method and colorimetric method.[1]

The brucine and strychnine alkaloids which occur in nux vomica, a natural source, are in optically active form. Therefore, it was thought proper to study the extraction of nux vomica for their alkaloidal content polarimetrically.

Nux vomica seeds, locally available from market were dried, chopped and ground to No. 100 powder. Nux vomica powder

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(25 g.) was mixed with chloroform (85 ml.) and ether (175 ml.), stirred throughly and allowed to stand for 10 minutes. To this was added ammonia solution (3 N; 10 ml.) and the mixture shaken continuously for about 8 hours. The solvent extract was filtered, washed with ether and the filtrate extracted with 1 N sulphuric acid (50 ml.) and successively with further quantity of sulphuric acid (15 ml.) until the alkaloids were completely extracted. The combined acidic extract was made alkaline with strong ammonia. The precipitated total alkaloids were extracted twice with chloroform (40 ml.). The successive extraction was continued with chloroform (15 ml.) until the alkaloids were completely extracted.

The combined chloroform extracts was evaporated to remove chloroform and afterwards ethyl alcohol (95%; 15 ml.) was added and the contents evaporated completely to dryness.

The residue containing mixed alkaloids was washed with very small quantity of methanol wherein brucine is more soluble than strychnine and so both could be separated from one another. The strychnine was purified, m. p. 276–78°, $[\alpha]_D^{33}$ −144·5 (*1*, i; *c*, 2 in chloroform).

The methanol washings on evaporation gave crude brucine, which was purified by crystallisation, m. p. 178°, $[\alpha]_D^{33}$ − 121·0 (*1*, i; *c*, 2 in chloroform).

In order to study the amount of brucine and strychnine alkaloids in the extracts of nux vomica, the optical rotations of known variable percentage compositions of brucine and strychnine obtained as above were first determined by taking artificially prepared mixtures of known percentages (Table I) and plotting the optical rotations against known percentage compositions (Table II). On comparison of the rotations of the extracts, the percentage composition of brucine and strychnine in a mixture was determined.

The optical rotation of extracted mixed alkaloids from nux vomica is $[\alpha]_D^{33}$ − 131·3 (*1*, i: *c*, 2 in chloroform). Looking to the values from the graph the percentage composition of strychnine and brucine is 44% to 56%, i.e., 1 : 1·25.

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TABLE I

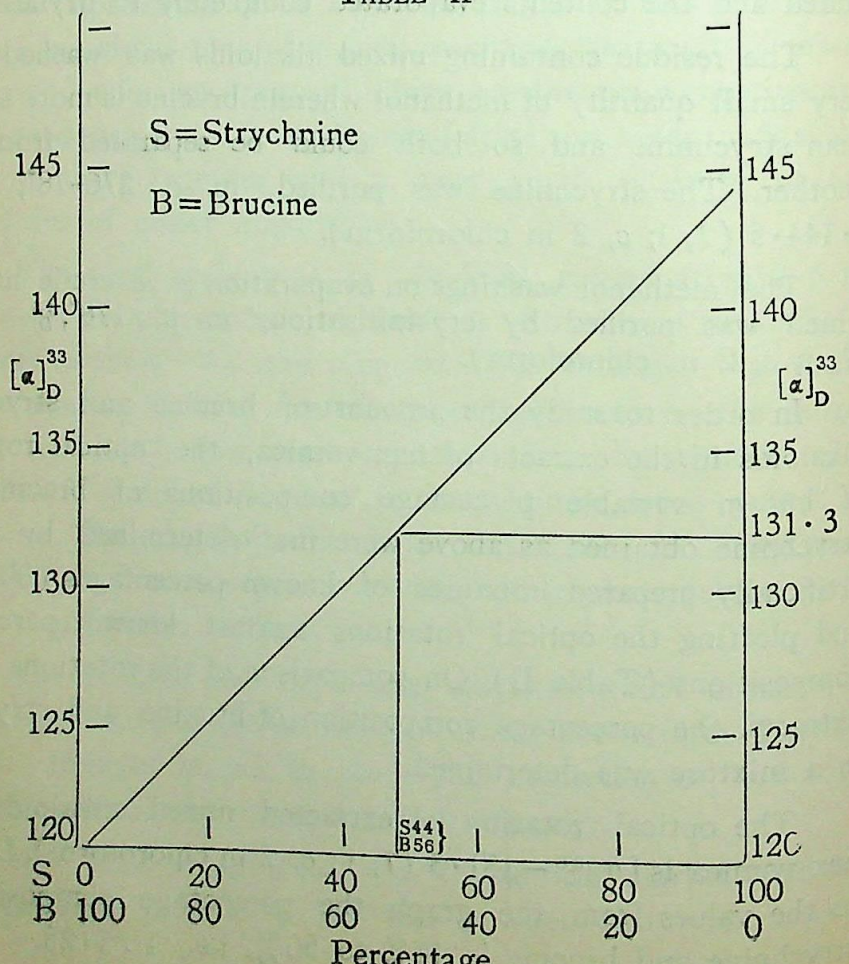
Optical rotations of mixed alkaloids, brucine and strychnine in different proportions

Percentage of Brucine%	*Percentage of Strychnine %*	*Optical rotations* $[\alpha]_D^{33}$ (*l*, i; *c*, *2 in chloroform*)
0·0	100·0	−144·5
20·0	80·0	−140·0
40·0	60·0	−135·2
60·0	40·0	−130·5
80·0	20·0	−125·7
100·0	0·0	−121·0

The authors are thankful to Principal C. S. Shah, L. M. College of Pharmacy for facility to powder the nux vomica.

Reference : Garratt D. C. : 'The quantitative analysis of drugs', 3rd edition, p. 459.

TABLE II



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THE EFFECT OF DIELECTRIC CONSTANT ON THE AVERAGE IONIC DIAMETER OF DIETHYLDITHIOCARBAMATE

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It is a known fact that the dissociation of an acid is affected by the change in dielectric constant. In the present work attempts have been made to study the correlation between the dielectric constant and the dissociation constant of diethyldithiocarbamic acid.

Experimental

The various solvents used for study were acetone, ethyl alcohol and dioxan. Ethyl alcohol was distilled before use and was taken to be 100% (no attempt was made to destroy the azeotrope). Dioxan was purified by adding sodium hydroxide, refluxing and then distilling it. Acid used were of A.R. quality and were standardized against anhydrous sodium carbonate[1]. pH in mixed solvents were measured using Beckman pH meter (model H_2) equipped with glass and fibrous type saturated calomel electrodes (limit of accuracy of pH meter ± 0.05 unit). No attempt was made either to calibrate the glass electrode system or to allow for the liquid—liquid junction potential. Ionic strength was also not maintained. To different millimolar solutions of sodium diethyldithiocarbamate (NaDDTC) in mixed solvents, $HClO_4$ was added. The data are presented only graphically for the sake of brevity.

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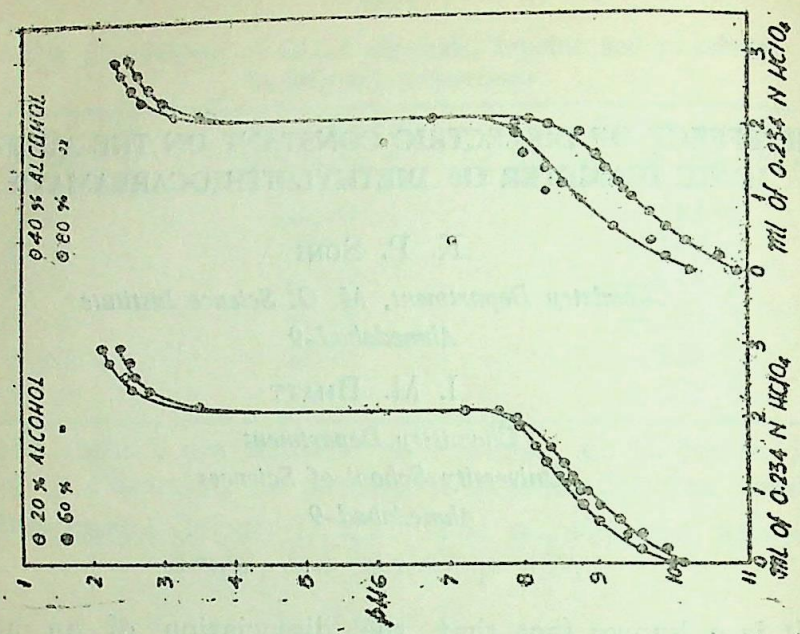

Fig. 2

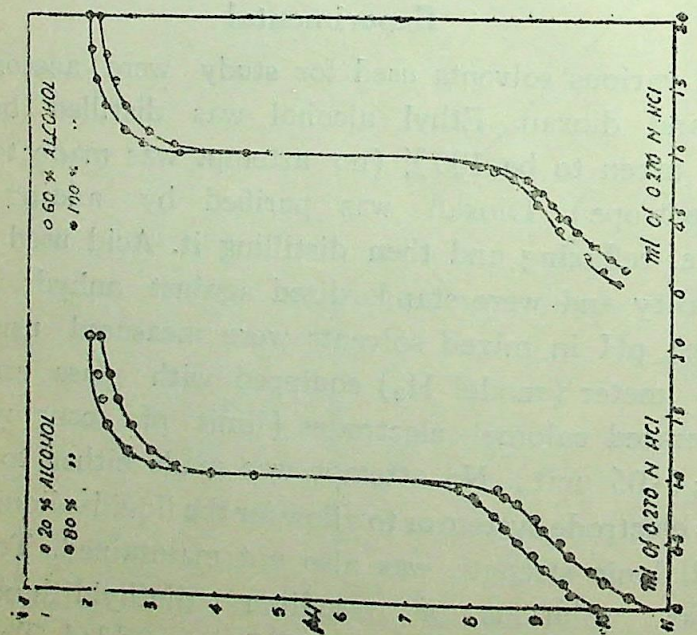

Fig. 1

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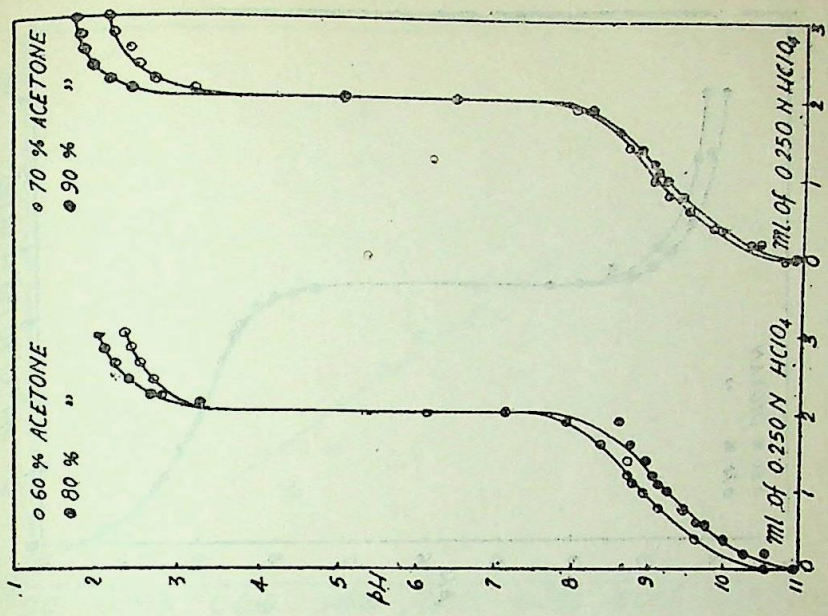

Fig. 4

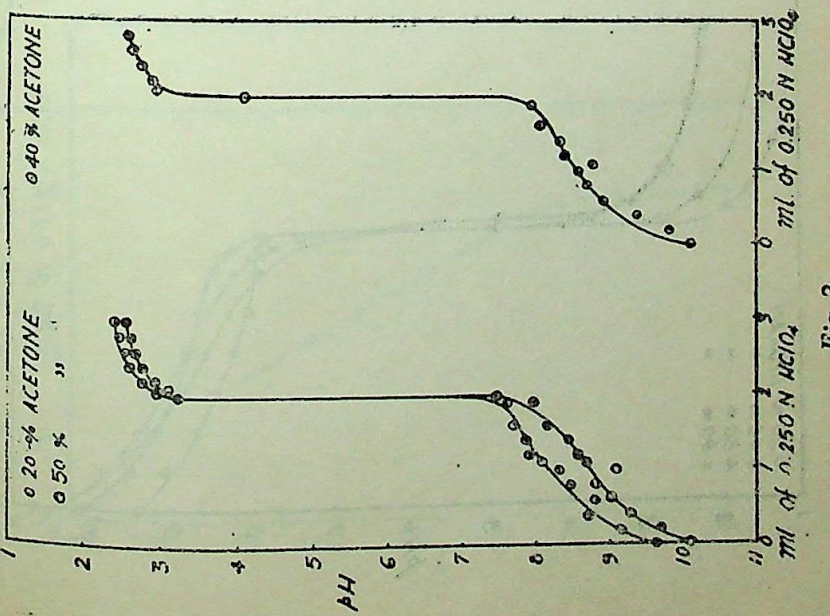

Fig. 3

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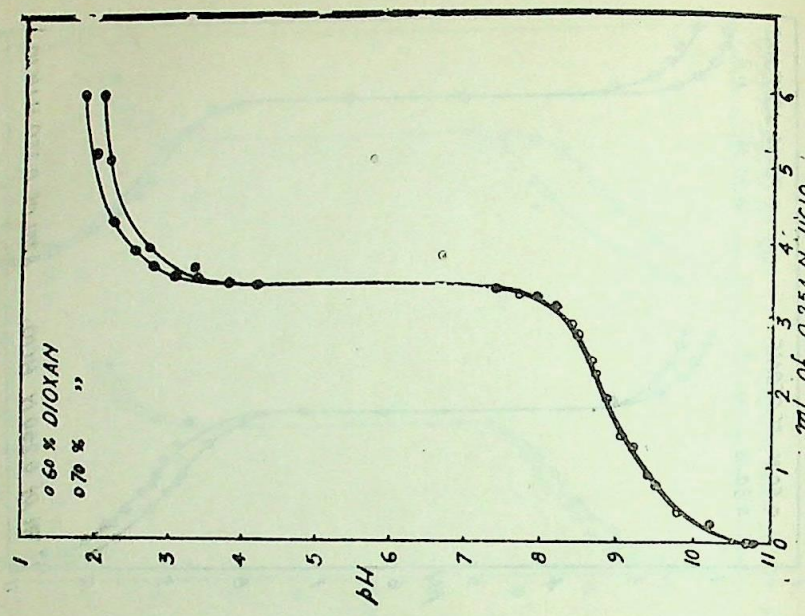

Fig. 6

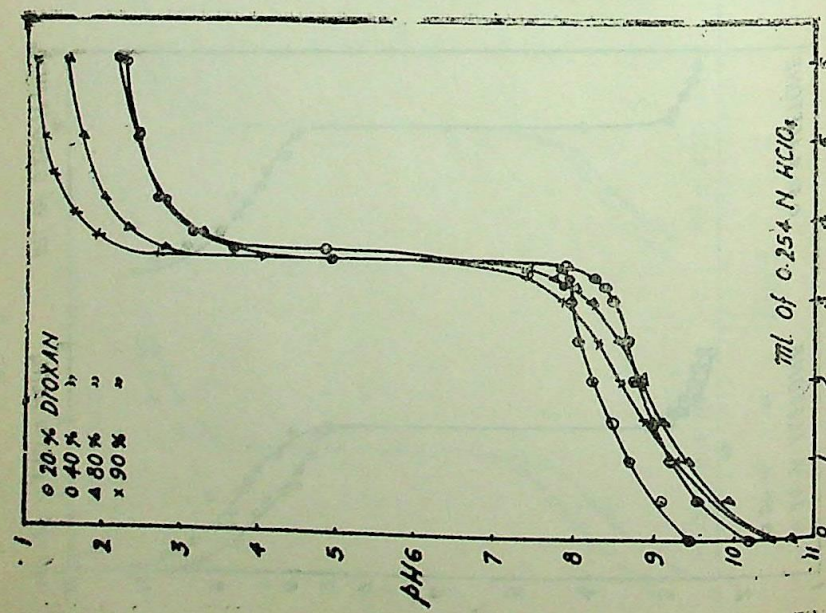

Fig. 5

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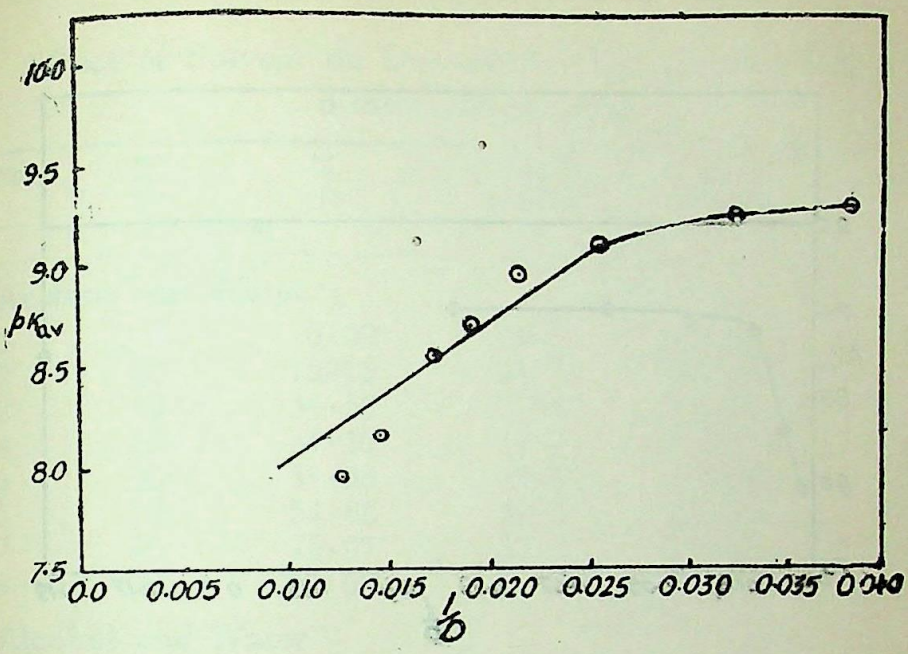

Fig. 7

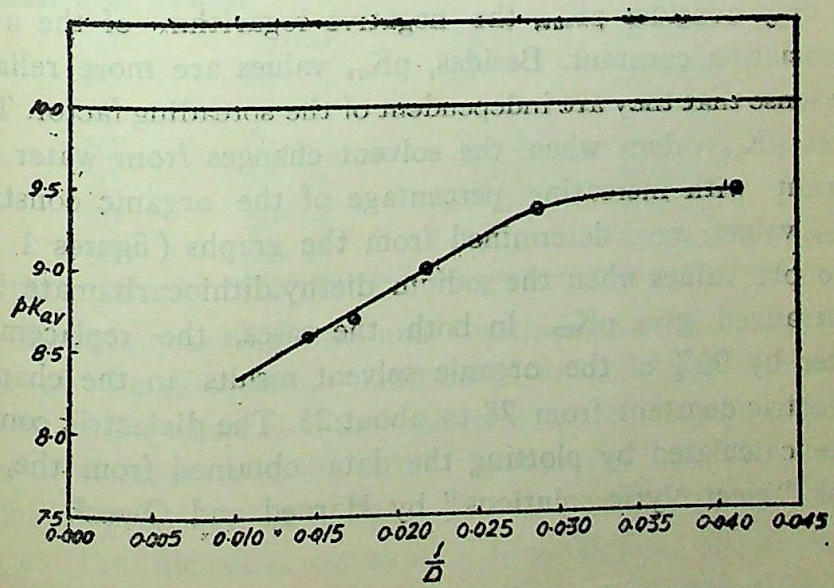

Fig. 8

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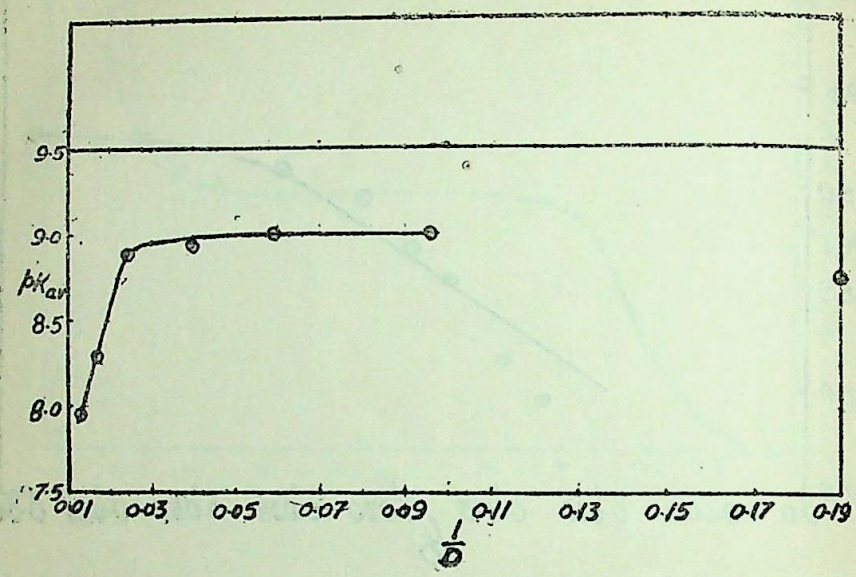

Fig. 9

We shall discuss the data of ethyl alcohol and acetone together. The difference between pK_1 and pK_2 (corresponding to 3/4 and 1/4 neutralization) remains almost the same, hence, we may consider pK_{av}, the negative logarithm of the average dissociation constant. Besides, pK_{av} values are more reliable in the sense that they are independent of the spreading factor. Table I gives pK_{av} values when the solvent changes from water to the solvent with increasing percentage of the organic constituent. pK_{av} values were determined from the graphs (figures 1 to 6). The pH values when the sodium diethyldithiocarbamate is half neutralized give pK_{av}. In both the cases, the replacement of water by 90% of the organic solvent results in the change of dielectric constant from 78 to about 25. The dielectric constants were calculated by plotting the data obtained from the, 'text-book "electrolytic solutions" by Harned and Owen[2].

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TABLE I

Effect of Solvent on Dissociation Constants of Diethyldithiocarbamic acid

No.	% *v/v* *Solvent*	% *w/w*	*Dielectric constant D*	*1 / D*	pK_{av}
Acetone and Water					
1	0	0·00	78·5	0·0127	7·95
2	20	16·15	69·0	0·0145	8·15
3	40	34·52	57·8	0·0173	8·55
4	50	44·16	51·7	0·0193	8·70
5	60	54·38	45·8	0·0218	8·95
6	70	64·86	39·8	0·0258	9·10
7	80	75·97	30·5	0·0328	9·25
8	90	87·68	26·6	0·0385	9·30
Alcohol and Water					
1	0	0·00	78·5	0·0127	7·95
2	20	16·40	68·8	0·0145	8·60
3	40	34·34	58·0	0·0172	8·70
4	60	54·06	46·2	0·0217	9·00
5	80	75·82	35·0	0·0288	9·35
6	100	100·00	24·3	0·0412	9·45
Dioxan and Water					
1	0	0·00	78·5	0·0127	7·95
2	20	20·62	60·4	0·0166	8·30
3	40	40·92	42·2	0·0237	8·90
4	60	60·95	25·0	0·0400	8·95
5	70	70·94	17·0	0·0588	9·00
6	80	80·61	10·4	0·0959	9·00
7	90	90·33	5·3	0·1897	8·75

According to Kilpatrik[3] and Lynch and La Mer[4], the logarithm of the dissociation constant of an acid is a linear function of 1/D (where *D* is the dielectric constant of the medium), when *D* changes from 80 to 25. Figures 7, 8 and 9 give the graphs of pK_{av} against 1/D. It will be observed from Table I, that as the dielectric constant is lowered pK_{av} increases, i.e., the dissociation constant decreases. This is according to Nerst-Thompson rule. According to this rule, the degree of dissociation

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of a solute at a given concentration in various solvents increases with the increase in dielectric constant. This concept is based upon the fact that the force between the two ions is inversely proportional to the dielectric constant. Hence, the greater the dielectric constant less is the probability of the association of two ions to form an undissociated ion molecule. However, no strict parallelism between dielectric constant and degree of dissociation could be expected, even if, ionic solvation were totally dependent on polar and inductive forces. "The ion-solvent interaction is by no means always totally electrostatic, as already seen, so that with this and other points mentioned above, it is evident that the Nerst-Thompson rule would not be expected to be a good generalisation. This is strikingly confirmed by the fact that the same quantity of a given salt can be disssociated to quite different extents in, say methyl alcohol and nitrobenzene, dielectric constants of which are nearly equal"[5].

The graph in case of acetone, has almost the same slope as in case of ethyl alcohol (figures 7 and 8 respectively), until 1/D is nearly equal to 0·03. Subsequent increase of 1/D results in the graph becoming almost parallel to x-axis. Lynch and La Mer[4] have calculated the minimum distance of approach of the two ions, r=a=average diameter in A° of the ion from the slope of the curve of pK against 1/D. Table II given by Lynch and La Mer shows the relation between 'D' and 'A'.

TABLE II

Acid	*D*	10^8a
Acetic, Propionic and	78–21·0	2·6
Butyric	11·7	9·4
Benzoic	78	1·3
	34·3	1·9
	21·0	3·2
	11·7	9·4

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Following the procedure of Lynch and La Mer for the diethyldithiocarbamic acid, the average value of 10^8a (243·3 / slope) comes out to be of the order of 4, when D changes from 78 to 40. We shall now consider the change in pK_{a_v} with the change in dielectric constant of the medium. When the mixed solvent contains acetone or alcohol, decrease in the dielectric constant (from 78 to 23) results in a certain increase in pK_{a_v}. In the dioxan-water system, corresponding decrease in dielectric constant also results in the increase in pK_{a_v}, but to a lesser extent. Again, in the dioxan-water system, a stage is soon reached where further decrease in dielectric constant (from 25 to 5) has little influence on the dissociation constant. Since no allowance has been made for the liquid—liquid junction potential and the behaviour of the glass electrode system in mixed solvents, it would not be desirable to make further deductions from the data.

The authors are thankful to Dr. A. M. Trivedi for the interest in the work and to Mr. S. K. Patel for checking the analytical data. Thanks are due to the Ahmedabad Education Society for laboratory facilities.

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ADDITIONS TO THE FLORA OF VALLABH VIDYANAGAR AREA

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Sardar Patel University, Vallabh Vidyanagar

Introduction

In a previous paper, the authors enumerated about 357 plants collected from the areas in vicinity of Vallabh Vidyanagar, Kaira District, Gujarat. Since then, the authors have been intensively exploring the areas with a view to complete the information about the flora of Vallabh Vidyanagar. The list consists of hither to unreported cultivated and wild plants growing in the present area. Most of the cultivated plants are grown in Botanical Garden, V. P. Mahavidyalaya and some are good avenue trees. The identification of cultivated plants was made with the help of available books such Bailey (1949, 1961); Bor and Raizada (1954) and Blatter and Millard (1954).

Most of the plants collected from the area are deposited in the herbarium of Botany Department, Sardar Patel University, Vallabh Vidyanagar and their collection numbers are given. For the nomenclature of wild plants we have followed Santapau (1953, 1962) and Raizada (1958, 1966) whereas for the names of cultivated plants those as they appear in books consulted. Where the name is different from that given in Cooke's flora the name given by Cooke is given as a synonym.

ENUMERATION OF PLANTS

RANUNCULACEAE

Clematis gourlana Roxb. ex. DC. (*Inamdar*, 569)

Delphinium majus L. (*Inamdar*, 570)

MAGNOLIACEAE

Michelia champaca L. (*Inamdar*, 571)

ANNONACEAE

Artabotrys uncinatus (Lamk.) Merrill (*Inamdar*, 572)

Artabotrys odoratissimus R. Br.

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NYMPHAEACEAE

Nelumbo nucifera Gaertn. (*Inamdar*, 358)

Nelumbium speciosum Willd,

Nymphaea nouchali Burm. f. (*Inamdar*, 359)

Nymphaea lotus Hook. f, & Thomas

PAPAVERACEAE

Papaver rhoeas L. (*Inamdar*, 573)

CRUCIFERAE

Brassica oleracea L. (*Inamdar*, 575)

Iberis umbellata L, (*Inamdar*, 574)

Lepidium sativum L, (*Inamdar*, 576)

Raphanus sativus L. (*Inamdar*, 578)

Raphanus sativus var. *caudatus* L. (*Inamdar*, 577)

CAPPARACEAE

Capparis zeylanica L. non Hk. f, & Th. (*Inamdar*, 579)

Capparis horrida L. f.

CARYOPHYLLACEAE

Polycarpon prostratum (Forsk.) Archers & Schwein f. (*Inamdar*, 581)

Polycarpon loeflingiae Bth. & Hook.

Vaccaria pyramidata Medik. (*Inamdar*, 580)

Saponaria vaccaria L.

PORTULACACEAE

Portulaca grandiflora Hook. (*Inamdar*, 360)

Portulaca suffruticosa Wight (*Inamdar*, 361)

GUTTIFEREAE

Calophyllum inophyllum L. (*Inamdar*, 581)

MALVACEAE

Abelmoschus manihot (L.) Medik. (*Inamdar*, 364)

Hibiscus tetraphyllus Roxb.

Abutilan glaucum (Cav.) Sweet (*Inamdar*, 363)

Abutilon muticum Sweet

Althaea rosea Cav. (*Inamdar*, 583)

Hibiscus rosa-sinensis L. (*Inamdar*, 367)

Malvaviscus arboreus Cav. (*Inamdar*, 366)

Achania malvaviscus Swartz

Thespesia populnea (L.) Soland. (*Inamdar*, 365)

Urena lobata L. (*Inamdar* 362)

Urena sinuata L.

BOMBACACEAE

Adansonia digitata L. (*Inamdar*, 584)

STERCULIACEAE

Firmiana colorata R. Br. (*Inamdar*, 586)

Sterculia colorata Roxb.

Guazuma tomentosa HBK. (*Inamdar*, 368)

Pentapetes phoenicea L. (*Inamdar*, 369)

Pterospermum acerifolium Willd. (*Inamdar*, 586)

Sterculia foetida L. (*Inamdar*, 587)

TILIACEAE

Grewia asiatica L. (*Inamdar*, 588)

Grewia tenax (Forsk.) Fiori (*Inamdar*, 370)

Grewia populifolia Vahl

LINACEAE

Linum grandiflorum Desf. (*Inamdar*, 589)

MALPIGHIACEAE

Hiptage benghalensis (L.) Kurz. (*Inamdar*, 590)

Hiptage madablota Gaertn.

Galphimia gracilis Bartl. (*Inamdar*, 591)

Tristellateia australasea A. Rich. (*Inamdar*, 592)

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ZYGOPHYLLACEAE

Guaiacum officinale L (*Inamdar*, 371)

GERANIACEAE

Impatiens balsamina L. (*Inamdar*, 373)

Tropaeolum majus L. (*Inamdar*, 372)

RUTACEAE

Citrus decumina Murr. (*Inamdar*, 374)

Citrus medica L. (*Inamdar*, 375)

Citrus medica var. *acida* L. (*Inamdar* 376)

Glycosmis pentaphylla (*Retz*) Corr. (*Inamdar*, 378)

Murraya paniculata (L.) Jack. (*Inamdar*, 376)

Murraya exotica L.

Murraya koenigii (L.) Spreng. (*Inamdar*, 393)

Triphasia trifolia P. Wilson (*Inamdar*, 379)

Triphasia aurantiola Lour.

MELIACEAE

Toona ciliata Roem. (*Inamdar*, 594)

Cedrella toona Roxb.

VITACEAE

Cissus quadrangularis Planch. (*Inamdar*, 595)

Vitis quadrangularis L.

Vitis vinifera L. (*Inamdar*, 596)

SAPINDACEAE

Dodonaea viscosa (L.) Jacq. (*Inamdar*, 380)

ANACARDIACEAE

Anacardium occidentale L. (*Inamdar*, 381)

Sclerocarya caffra Sond. (*Inamdar*, 597)

Spondias pinnata (L.f.) Kurz. (*Inamdar*, 598)

Spondias mangifera Willd.

PAPILIONACEAE

Alhagi pseudalhagi (M. Bieb.) Desv. (*Inamdar*, 599)

Alhagi camelorum Fisch.

Alysicarpus glumaceus (Vahl.) DC. (*Inamdar*, 383)

Alysicarpus rugosus (Willd.) DC.

Alysicarpus procumbens (Roxb.) Schindler (*Inamdar*, 382)

Alysicarpus hamosus Edgew.

Crotalaria mysorensis Roth. (*Inamdar*, 384)

Crotalaria sericea Retz. (*Inamdar*, 385)

Desmodium parviflorum (Dalz.) Baker (*Inamdar*, 386)

Desmodium renifolium (L.) Schindler (*Inamdar*, 387)

Dolichos lablab L. (*Inamdar*, 388)

Eleiotis trifoliolata Cooke (*Inamdar*, 389)

Erythrina variegata L. var. *orientalis* (L.) Merr. (*Inamdar*, 600)

Erythrina indica Lamk.

Glycine soja Sieb. and Zucc. (*Inamdar*, 390)

Gliricidia sepium (Jacq.) Walp. (*Inamdar*, 601)

Gliricidia maculata HBK.

Phaseolus mungo L. (*Inamdar*, 392)

Phaseolus aconitifolius Jacq. (*Inamdar*, 391)

Phaseolus radiatus L. (*Inamdar*, 493)

Psoralea corylifolia L. (*Inamdar*, 394)

Sesbania sesban (L.) Merr. (*Inamdar*, 395)

Sesbania aegyptiaca Poir.

Sesbania grandiflora Pers. (*Inamdar*, 396)

Taverniera cuneifolia Arn. (*Inamdar*, 398)

Taverniera nummularia DC.

Vigna unguiculata (L.) Walp. (*Inamdar*, 399)

Vigna sinensis (L.) Savi ex Hassk.

Vigna catjang Walp.

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CAESALPINIACEAE

Bauhinia purpurea L. (*Inamdar*, 603)
Bauhinia variegata L. (*Inamdar*, 602)
Cassia fistula L. (*Inamdar*, 605)
Cassia javanica L. (*Inamdar*, 400)
Cassia roxburghii DC. (*Inamdar*, 401)
Cassia marginata Roxb.
Cassia siamea Lamk. (*Inamdar*, 403)
Delonix regia (Boj.) Raf. (*Inamdar*, 606)
Poinciana regia Boj.
Parkinsonia aculeata L. (*Inamdar*, 405)
Peltophorum pterocarpum (DC.) Baker (*Inamdar*, 406)
Peltophorum ferrugineum (Decne.) Benth.
Poinciana pulcherrima L. (*Inamdar*, 404)
Caesalpinia pulcherrima SW.
Saraca indica L. Mant. (*Inamdar*, 607)

MIMOSEAE

Acacia concinna (Willd.) DC. (*Inamdar*, 407)
Acacia intsia Willd. (*Inamdar*, 408)
Albizzia chinensis (Osbeck) Merr. (*Inamdar*, 409)
Albizzia stipulata Boiv.
Leucaena leucocephala (Lamk.) de Wit. (*Inamdar*, 410)
Leucaena glauca Benth.
Neptunia oleracea Lour. (*Inamdar*, 411)
Parkia biglandulosa W. & A. (*Inamdar*, 412)
Samanea saman Merr. (*Inamdar*, 413)
Pithecellobium saman Bth.

CRASSULACEAE

Kalanchoe pinnata Pers. (*Inamdar*, 608)
Bryophyllum pinnata Kurz
Bryophyllum calycinum Salisb.
Kalanchoe verticillata Elliot (*Inamdar*, 609)
Bryophyllum tubiflorum Harvey

COMBRETACEAE

Anogeissus pendula Edgew. (*Inamdar*, 414)
Combretum coccineum Lamk. (*Inamdar*, 610)
Quisqualis indica L. (*Inamdar*, 616)
Terminalia arjuna (Roxb. ex. DC.) W. & A. (*Inamdar*, 662)
Terminalia catappa L. (*Inamdar*, 415)

MYRTACEAE

Callistemon lanceolatus DC. (*Inamdar*, 611)
Eucalyptus globulus Labill. (*Inamdar*, 417)
Myrtus communis L. (*Inamdar*, 418)
Psidium guajava L. (*Inamdar*, 419)
Psidium gujava L.

LECYTHIDACEAE

Couroupita guianensis Aubl. (*Inamdar*, 612)

LYTHRACEAE

Lagerstroemia speciosa (L.) Pers. (*Chohan*, 420)
Lagerstroemia flos-reginae Retz.
Lagerstroemia indica L. (*Chohan*, 421)

PUNICACEAE

Punica granatum L. (*Chohan*, 422)

PASSIFLORACEAE

Passiflora edulis Sims (*Chohan*, 424)
Passiflora minima L. (*Chohan*, 423)

CARICACEAE

Carica papaya L. (*Chohan*, 425)

CUCURBITACEAE

Benincasa hispida (Thunb.) Cogn. (*Chohan*, 426)
Benincasa cerifera Savi
Citrullus lanatus (Thunb.) Mansfie (*Chohan*, 427)

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Cucumis melo L. var. *momordica* Duthie and Fuller (*Chohan*, 428)
Cucumis sativus L. (*Chohan*, 429)
Cucurbita pepo L. (*Chohan*, 430)

CACTACEAE

Opuntia elatior Mill. (*Chohan*, 613)

FICOIDEAE

Gisekia pharnaceoides L. Mant. (*Chohan*, 432)

MOLLUGINACEAE

Mollugo nudicauls Lamk. (*Chohan*, 433)

UMBELLIFERAE

Coriandrum sativum L. (*Chohan*, 435)
Cuminum cyminum L. (*Chohan*, 614)

RUBIACEAE

Gardenia jasminoides Ellis (*Chohan*, 615)
Gardenia florida L.
Hamelia patens Jacq. (*Chohan*, 434)
Hymenodictyon excelsum (Roxb.) Wall. (*Chohan*, 436)
Ixora parviflora Vohl (*Inamdar*, 438)
Morinda citrifolia L. (*Chohan* 439)

COMPOSITAE

Chrysanthemum indicum L. (*Chohan*, 516)
Cosmos bipinnatus Cav. (*Chohan*, 617)
Eupatorium odoratum Vahl (*Chohan*, 618)
Helianthus annuus L. (*Chohan*, 619)
Helianthus rigidus Desf (*Chohan*, 620)
Pluchea wallichiana DC. (*Chohan*, 621)
Solidago canadensis L. (*Chohan*, 622)
Spilanthes acmella Murr. (*Chohan*. 623)
Tagetes patula L. (*Chohan*, 422)
Tagetes erecta L. (*Chohan*, 441)
Vernonia cinerea (L.) Less (*Chohan*, 440)
Vicoa indica (Willd.) DC. (*Chohan*, 624)
Vicoa auriculata Cass.

PLUMBAGINACEAE

Plumbago capensis Thunb. (*Chohan*, 443)

SAPOTACEAE

Achras zapota L. (*Chohan*, 625)
Chrysophyllum cainito L. (*Chohan*, 445)

EBENACEAE

Diospyros kaki L. f. (*Chohan*, 626)

OLEACEAE

Jasminum auriculatum Vahl (*Chohan*, 450)
Jasminum flexile Vahl (*Inamdar*, 447)
Jasminum officinale L. (*Inamdar* 448)
Jasminum sambac (L.) Ait. (*Inamdar*, 446)

APOCYNACEAE

Aganosma dichotoma (Roth) K. Schum. (*Inamdar*, 451)
Aganosma caryophyllata G. Don
Allamanda cathartica (L.) HK. (*Inamdar*, 663)
Alstonia scholaris (L.) R. Br. (*Inamdar*, 627)
Carissa congesta Wight (*Inamdar*, 452)
Carissa carandas L.
Catharanthus roseus Don (*Inamdar*, 454)
Vinca rosea L.
Nerium indicum Mill. (*Inamdar*, 455)
Nerium odorum Soland.
Plumeria alba L. (*Inamdar* 546)
Plumeria rubra L. forma *acuminata* (Ait.) Santapau & Irani (*Inamdar*, 457)
Plumeria acuminata Ait.
Plumeria acuminata Poir.
Plumeria rubra L. *forma acutifolia* (Poir.) Woodson
Tabernaemontana divaricata (L.) R. Br. (*Inamdar*, 459)
Ervatamia coronaria Stapf
Thevetia peruviana (Pers.) Merr. (*Inamdar*, 454)
Cerbera thevetia L.

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Vallaris solanacea (Roth) O. K. (*Inamdar*, 458)

Vallaris heynei Spreng.

ASCLEPIADACEAE

Tylophora indica (Burm. f.) Merr. (*Inamdar*, 628)

Tylophora asthmatica W. & A.

POLEMONIACEAE

Phlox drummondii HK. (*Inamdar*, 629)

BORAGINACEAE

Cordia sebestena L. (*Inamdar*, 460)

Echium vulgare L. (*Inamdar*, 461)

CONVOLVULACEAE

Argyreia nervosa (Burm. f.) Boj. *Inamdar*, 462)

Argyreia speciosa Sweet

Hewittia bicolor Wt & A. (*Inamdar*, 463)

Ipomoea aquatica Forsk. (*Inamdar*, 454)

Ipomoea batatas (L.) Lamk. (*Inamdar*, 465)

Ipomoea eriocarpa R. Br. (*Inamdar*, 466)

Ipomoea dichroa (R. & S.) Choisy (*Inamdar*, 467)

Ipomoea pilosa Sw.

Ipomoea nil (L.) Roth (*Inamdar*, 468)

Ipomoea hederacea auct. non Jacq.

Ipomoea pes-caprae (L.) Sw. (*Inamdar*, 630)

Ipomoea biloba Forsk.

Ipomoea pulchella Roth. (*Inamdar*, 469)

Ipomoea triloba L. (*Inamdar*, 472)

Merremia chryseides Hall. (*Inamdar*, 474)

Merremia quinquefolia Hall. f. (*Inamdar*, 475)

Operculina turpethum (L.) Silva (*Chohan*, 473)

Rivea hypocrateriformis Choisy (*Inamdar*, 476)

SOLANACEAE

Cestrum diurnum L. (*Inamdar*, 478)

Cestrum nocturnum L. (*Inamdar*, 477)

Petunia violacea Lindl. (*Inamdar*, 631)

SCROPHULARIACEAE

Antirrhinum majus L. (*Inamdar*, 632)

Lindernia parviflora (Roxb) Haines (*Inamdar*, 479)

Ilysanthes parviflora Bth.

Russelia equisetiformis Schlecht and Chem. (*Inamdar*, 480)

Russelia juncea Zucc.

BIGNONIACEAE

Crescentia alata L. (*Inamdar*, 634)

Crescentia cujete L. (*Inamdar*, 633)

Heterophragma adenophyllum (Wall.) P. Dop. (*Inamdar*, 635)

Jacaranda acutifolia Humb. & Bonpl. (*Inamdar*, 482)

Jacaranda mimosaefolia D. Don.

Millingtonia hortensis L. f. (*Inamdar*, 483)

Pyrostegia venusta (Ker-Gawl.) Meirs (*Inamdar*, 481)

Bignonia venusta Ker-Gawl.

Spathodea campanulata Beauv. (*Inamdar*, 484)

Tecoma radicans Juss. (*Inamdar* 486)

Tecoma stans (L.) HB. & K. (*Inamdar*, 485)

ACANTHACEAE

Adhatoda vasica Nees (*Inamdar*, 536)

Asystasia gangetica T. Ander. (*Inamdar*, 437)

Asystasia coromandeliana Nees

Dicliptera micranthes Nees (*Inamdar*, 488)

Justicia gendarussa Burm. f. (*Inamdar*, 489)

Pseuderanthemum bicolor (Schrank) Radlk et Lindau(*Inamdar*, 665)

Eranthemum bicolor Schrank

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VERBENACEAE

Callicarpa tomentosa (L.) Murray (*Inamdar*, 664)

Callicarpa lanata L.

Clerodendrum splendens G. Don (*Inamdar*, 490)

Citharexylum subserratum Sw. (*Inamdar*, 491)

Duranta repens L. (*Inamdar*, 492)

Duranta plumerii Jacq.

Gmelina arborea Roxb. (*Inamdar*, 637)

Nyctanthes arbor-tristis L. (*Inamdar*, 449)

Premna integrifolia L. (*Inamdar*, 493)

Stachytarpheta jamaicensis (L.) Vahl (*Inamdar*, 494)

Stachytarpheta indica Vahl

Tectona grandis L. f. (*Inamdar*, 495)

Verbena rigida Spreng. (*Inamdar*, 496)

Verbena venosa Gill and HK.

LABIATAE

Mentha spicata L. (*Inamdar*, 497)

Mentha viridis L.

Ocimum basilicum L. (*Inamdar*, 498)

Ocimum sanctum L. (*Inamdar*, 499)

Salvia officinalis L. (*Inamdar*, 638)

PLANTAGINACEAE

Plantago psyllium L. (*Chohan*, 639)

NYCTAGINACEAE

Bougainvillea spectabilis Willd. (*Inamdar*, 500)

Mirabilis jalapa L. (*Inamdar*, 501)

AMARANTHACEAE

Amaranthus blitum L. (*Inamdar*, 505)

Amaranthus caudatus L. (*Inamdar*, 506)

Amaranthus hybridus L. sub sp. *cruentus* Thell var. *paniculatus* Thell (*Inamdar*, 503)

Amaranthus paniculatus L.

Amaranthus polygamus L. (*Inamdar*, 502)

Amaranthus tenuifolius Willd. (*Inamdar*, 504)

Celosia cristata L. (*Inamdar*, 507)

Gomphrena globosa L. (*Inamdar*, 640)

Nothosaerva brachiata (L.) Wight (*Inamdar*, 508)

Telanthera ficoidea Moq. (*Inamdar*, 509)

CHENOPODIACEAE

Beta vulgaris L. (*Inamdar*, 510)

Chenopodium murale L. (*Inamdar*, 642)

Kochia indica Wight (*Inamdar*, 641)

BASELLACEAE

Basella rubra L. (*Inamdar*, 511)

POLYGONACEAE

Antigonon leptopus Hook. and Arn. (*Inamdar*, 512)

Polygonum glabrum Willd. (*Inamdar*, 513)

ARISTOLOCHIACEAE

Aristolochia indica L. (*Inamdar*, 514)

PROTEACEAE

Grevillea robusta A. Cunn. (*Inamdar*, 643)

SANTALACEAE

Santalum album L. (*Inamdar*, 515)

EUPHORBIACEAE

Acalypha indica L. (*Inamdar*, 516)

Acalypha wilkesiana Muell-Arg. (*Inamdar*, 517)

Cicca acida (L.) Merrill (*Inamdar*, 648)

Phyllanthus distichus Muell-Arg.

Euphorbia antiquorum L. (*Inamdar*, 644)

Euphorbia splendens Boj. (*Inamdar*, 645)

Jatropha curcas L. (*Inamdar*, 518)

Jatropha gossypifolia L. (*Inamdar*, 520)

Jatropha panduraefolia Andr. (*Inamdar*, 519)

Manihot utilissima Pohl. (*Inamdar*, 646)

Pedilanthus tithymaloides Poit. (*Inamdar*, 647)

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Phyllanthus maderaspatensis L.
(*Inamdar*, 521)

MORACEAE

Ficus carica L. (*Inamdar*, 522)
Ficus elastica Roxb. (*Inamdar*, 649)
Morus alba L. (*Inamdar*, 650)

HYDROCHARITACEAE

Vallisneria spiralis L. (*Inamdar*, 651)

ZINGIBERACEAE

Alpinia galanga Swartz
(*Inamdar*, 652)

CANNACEAE

Canna indica L. (*Inamdar*, 523)

MUSACEAE

Musa paradisiaca L. (*Inamdar*, 524)
Revenala madagascarensis Sonn.
(*Inamdar*, 653)

HAEMODORACEAE

Sansevieria zeylanica Willd.
(*Inamdar*, 525)

AMARYLLIDACEAE

Crinum asiaticum L. (*Inamdar*, 527)
Pancratium parvum Dalz.
(*Inamdar*, 526)
Polianthes tuberosa L. (*Inamdar*, 528)
Zephyranthes atamasco Herb.
(*Deshpande*, 529)

AGAVACEAE

Agave americana L. (*Deshpande*, 667)

DIOSCOREACEAE

Dioscorea alata L. (*Deshpande*, 531)
Dioscorea bulbifera L.
(*Deshpande*, 530)
Dioscorea daemona Roxb.
(*Deshpande*, 532)

LILIACEAE

Aloe barbadensis Mill.
(*Deshpande*, 634)
Aloe vera L.
Allium cepa L. (*Deshpande*, 655)

SMILACACEAE

Smilax macrophylla Roxb.
(*Deshpande*, 656)

PONTEDERIACAE

Monocharia vaginalis Prest.
(*Deshpande*, 533)

COMMELINACEAE

Rhoea discolor Hance
(*Deshpande*, 534)

PALMAE

Areca catechu L. (*Deshpande*, 668)
Borassus flabellifer L.
(*Deshpande*, 657)
Caryota urens L. (*Deshpande*, 658)
Cocos nucifera L. (*Deshpande*, 535)
Phoenix sylvestris (L.) Roxb.
(*Deshpande*, 660)
Roystonea regia (H.B. and K.) O.K.
(*Deshpande*, 657)
Oreodoxa regia H. B. and K.

PANDANACEAE

Pandanus fascicularis Lamk.
(*Deshpande*, 536)
Pandanus tectorius Soland.

TYPHACEAE

Typha angustata Bory & Chaub.
(*Deshpande*, 537)

ARACEAE

Amorphophallus campanulatus (Roxb.) Bl. (*Deshpande*, 538)
Colocasia esculenta (L.) Schott
(*Deshpande*, 539)
Colocasia antiquorum Schott

ERIOCAULACEAE

Eriocaulon eleonarae Fyson
(*Chohan*, 543)

CYPERACEAE

Cyperus aristatus Rottb.
(*Deshpande*, 544)
Cyperus compressus L.
(*Deshpande*, 545)
Cyperus iria var. *paniciformis* C.B. Clarke (*Deshpande*, 546)
Fimbristylis woodrowii C. B. Clarke (*Deshpande*, 547)
Eleocharis atropurpurea Kunth
(*Deshpande*, 548)
Scirpus articulatus L.
(*Deshpande*, 547)

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GRAMINEAE

Andropogon pumilus Roxb. (*Deshpande*, 661)

Alloteropsis ciminica (L.) Stapf (*Deshpande*, 550)

Axonopus ciminicus (L.) P. Beauv.

Apocopis vaginata Hack. (*Deshpande*, 551)

Brachiaria setigera (Retz.) C. E. Hubb. (*Deshpande*, 552)

Chloris virgata Sw. (*Deshpande*, 554)

Digitaria sanguinalis var. *ciliaris* Prau. (*Deshpande*, 555)

Dinebra retroflexa (Vahl) Panz. (*Deshpande*, 556)

Eragrostis cilianensis (All) Vignolo-Lutali (*Deshpande*, 552)

Eragrostis major (L.) Host.

Eragrostis diarrhena (Schult.) Steud. (*Deshpande*, 561)

Eragrostis interrupta var. *koenigii* Stapf. ex Hook. f.

Eragrostis pilosa (L.) P. Beauv. (*Deshpande*, 564)

Eragrostis riparia (Willd.) Nees (*Deshpande*, 563)

Eragrostis tenella var. *riparia* Stapf

Eragrostis viscosa (Retz.) Trin. (*Deshpande*, 568)

Eragrostis tenella var. *riparia* Stapf

Eremopogon foveolatus (Del.) Stapf (*Deshpande*, 557)

Andropogon foveolatus Del.

Oplismenus burmanii (Retz.) P. Beauv. (*Deshpande*, 558)

Panicum miliare Lamk. (*Deshpande*, 560)

Sporobolus diander (Retz.) P. Beauv.

Tetrapogon tenellus (Roxb.) Choiv. (*Deshpande*, 553)

Chloris tenella Roxb.

Summary

The flowering plants of Vallabh Vidyanagar and its environs are enumerated here. In all about 299 plants have been listed of which 244 dicotyledons and 55 monocotyledons.

Acknowledgements

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ON THE SEQUENCE OF TRIANGULAR NUMBERS MODULO n

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1. If k is a positive integer, k th triangular number T_k is given by $T_k = k(k+1)/2$. Thus the sequence of triangular numbers is

1, 3, 6, 10, 15, 21, 28, 36, ...

This sequence will be called the T-sequence. If we reduce each term of the T-sequence mod n, we get the T-sequence mod n. E.g. T-sequence mod 10 is 1, 3, 6, 0, 5, 1, 8, 6, .. . In this note, we study properties of T-sequence mod n and determine those n for which a complete residue system (CRS) mod n occurs in the T-sequence.

2. We first prove that T-sequence mod n is periodic.

Theorem 2·1: The T-sequence mod $2n$ is periodic and the (smallest) period is $4n$.

Proof: We first show that if $a \equiv b \pmod{4n}$, then

$$T_a \equiv T_b \pmod{2n}.$$

So let $a \equiv b \pmod{4n}$, so that $a = 4nk + b$, for some k.

Now $T_a = (4nk+b)(4nk+b+1)/2$.

If b is even, $b = 2t$, then

$$T_a = (2nk+t)(4nk+2t+1) \equiv t(2t+1) = T_b \pmod{2n}.$$

Similarly if $b = 2t-1$, then $T_a \equiv (2t-1)t = T_b \pmod{2n}$.

This proves that the smallest period must be a divisor of $4n$.

If possible, let u be the smallest period and $u < 4n$, so that $4n = uu'$ with $u' > 1$. Then, for all b, we have $T_{u+b} \equiv T_b \pmod{2n}$ or $2(T_{u+b} - T_b) \equiv 0 \pmod{4n = uu'}$, i.e. $u^2 + (2b+1)u \equiv 0$

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$(\text{mod } uu')$ or $u+(2b+1)\equiv 0 \pmod{u'}$. Putting $b=1$ and $b=2$ in turn, it follows that $u' \mid (u+3)$, $u' \mid (u+5)$, so that $u' \mid 2$. Since $u'>1$, therefore $u'=2$.

Now $4n=uu'$. Hence $u=2n$. But if $2n$ were a period, we would have $T_{2n}\equiv T_{4n} \pmod{2n}$. However, it is easy to see that while $T_{2n}\neq 0$, $T_{4n}\equiv 0 \pmod{2n}$. This completes the proof.

Theorem 2·2: The T-sequence mod $2n-1$ is periodic and the period is $2n-1$.

Proof: Let $a\equiv b \pmod{2n-1}$, so that $a=(2n-1)k+b$.

Case I. k even, b odd, $k=2m$, $b=2t-1$; then

$$T_a=\{(2n-1)k+b\}\{(2n-1)m+t\}\equiv bt=b(b+1)/2=T_b \pmod{2n-1}.$$

Case II. k even, b even, $k=2m$, $b=2t$; then $(\text{mod } 2n-1)$,

$$T_a=\{(2n-1)m+t\}\{(2n-1)k+2t+1\}\equiv t(2t+1)=T_b.$$

Case III. k odd, b odd, $k=2m-1$, $b=2t-1$; then $(\text{mod } 2n-1)$,

$$T_a=\{(2n-1)m+(t-n)\}\{(2n-1)k+2t\}\equiv 2t(t-n)$$
$$\equiv 2t^2-t(2n-1)-t\equiv t(2t-1)=T_b.$$

Case IV. k odd, b even, $k=2m-1$, $b=2t$; then $(\text{mod } 2n-1)$,

$$T_a=\{(2n-1)k+b\}\{(2n-1)m+t-n+1\}\equiv b(t-n+1)$$
$$\equiv bt+b-t(2n-1)-t\equiv bt+b-t=b(b+1)/2=T_b.$$

Thus the period is a divisor of $2n-1$. If the period $u<2n-1$, then $2n-1=uu'$ and $u'>1$. Again, as in the last theorem, one can prove that $u'=2$. But $u' \mid (2n-1)$. Therefore $u'\neq 2$. Hence the period is $2n-1$.

3. We now examine the question of the existence or otherwise of a CRS mod n in the T-sequence. If a CRS mod n exists in the T-sequence, we say that n is a 'rare' number (the motivation behind this term will become clearer when we prove later that the density of the 'rare' numbers is zero).

Theorem 3·1: If n is not rare, then no multiple of n can be rare.

Proof: Suppose n is not rare but nt is, for some integer t. Thus for every u, $0\leqslant u\leqslant n-1$, there exists a triangular number

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T_k (which depends on u) such that $T_k \equiv u \pmod{nt}$; but then $T_k \equiv u \pmod{n}$. I.e. n is a rare number, which is not true.

Theorem 3·2 : If n is even, then for $1 \leqslant m \leqslant 2n-2$, we have

$T_m \equiv T_{2n-1-m} \pmod{n}$.

Proof :

$$T_{2n-1-m} - T_m = \{(2n-1-m)(2n-m) - m(m+1)\}/2$$
$$= (4n^2 - 4nm + m^2 - 2n + m - m^2 - m)/2$$
$$= n(2n-2m-1) \equiv 0 \pmod{n}.$$

We note that (for even n),

$$T_{2n-1} \equiv T_{2n} \equiv 0 \pmod{n}.$$

Theorem 3·3 : If n is odd, $n = 2k+1$, then for $0 \leqslant a \leqslant k-1$,

$$T_{k+a} \equiv T_{k-a} \pmod{n}.$$

Proof :

$$T_{k+a} - T_{k-a} = \{(k+a)(k+a+1) - (k-a)(k-a+1)\}/2$$
$$= (4ak + 2a)/2 = a(2k+1) = an \equiv 0 \pmod{n}.$$

Again we note that (for odd n),

$$T_{n-1} \equiv T_n \equiv 0 \pmod{n}.$$

As a trivial consequence of theorems 2·1 and 3·2, we have

Theorem 3·4 : If n is even, all the distinct residues mod n in the T-sequence are to be found in the set

$$\{T_1, T_2, T_3, .., T_{n-1}, 0\},$$

and hence n is a rare number if and only if the above set is a CRS mod n.

Similarly theorems 2·2 and 3·3 give

Theorem 3·5 : If n is odd, all the distinct residues mod n in the T-sequence are to be found in the set

$$\{T_1, T_2, T_3, .., T_k, 0\}, \text{ where } n = 2k+1.$$

Thus at most $k+1 = (n+1)/2$ distinct residues mod n occur in the T-sequence This proves

Theorem 3·6 : No odd integer (>1) is rare.

Theorem 3·7: An integer n is a rare number if and only if n is a power of 2 (Thus the asymptotic density of rare numbers is zero).

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Proof: If n is not a power of 2, then it has an odd factor greater than 1. Hence by theorems 3·6 and 3·1, n is not a rare number.

If n is a power of 2, let $n=2^t$.

We first show that if $k<n$, then $n \mid T_k$. If $n \mid T_k$, then it would follow that $k(k+1)\equiv 0 \pmod{2^{t+1}}$. Since k or $k+1$ is odd, this would imply that $2^{t+1} \mid (k+1)$ or $2^{t+1} \mid k$, both of which are impossible since $k<2^t$.

It follows from the above and from theorem 3·4 that if n is not rare, then there exist integers r, s such that $1 \leqslant s < r \leqslant 2^t-1$ with $T_r \equiv T_s \pmod{2^t}$.

This implies $r(r+1)-s(s+1)\equiv 0 \pmod{2^{t+1}}$,

i.e. $$(r-s)(r+s+1)\equiv 0 \pmod{2^{t+1}},$$

or since $r-s$ and $r+s+1$ are of opposite parity, we must have $2^{t+1} \mid (r-s)$ or $2^{t+1} \mid (r+s+1)$, both of which are again impossible since $1 \leqslant r-s < r+s+1 < 2^{t+1}$.

Hence $n=2^t$ is a rare number which completes the proof.

4. We now consider the number of zeros in a period of the T-sequence mod n.

Theorem 4·1: If n is an odd integer and $\theta(n)$ denotes the number of distinct prime divisors of n, then there are exactly $2^{\theta(n)}$ zeros in a period of the T-sequence mod n.

Peoof: Since (theorem 2·2) the length of a period is n, we must find the number of triangular numbers T_k with $k \leqslant n$ such that $n \mid T_k$. Now if $n \mid T_k$, then since n is odd, we must have $n \mid k(k+1)$. Thus for some divisor d of n, we have $d \mid k$ and $d' \mid (k+1)$, where $d'=n/d$. Since $(k, k+1)=1$, we have $(d, d')=1$. Conversely, if $dd'=n$ and $(d, d')=1$, then the pair of simultaneous congruences $x\equiv 0 \pmod{d}$, $x\equiv -1 \pmod{d'}$ has a unique solution $(\mathrm{mod}\ dd'=n)$ and if k is this solution, then $n \mid T_k$. Also, if m is the solution of the congruences $x\equiv 0 \pmod{d'}$, $x\equiv -1 \pmod{d}$, then $k \neq m$ and $n \mid T_m$. Thus to each $k \leqslant n$ for which $n \mid T_k$, there corresponds a pair (d, d') of complementary unitary divisors of n and to each such pair, there correspond two triangular numbers T_k, $k \leqslant n$ such that

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$n \mid T_k$. We now prove that two distinct pairs (d, d') and (e, e') of complementary unitary divisors of n cannot correspond to the same T_k. If this were possible, we would have

$$dd' = ee' = n,\ k = dm = en,\ k+1 = d'm' = e'n'.$$

Thus $dm = e'n' - 1$ and $d'm' = en + 1$,

which imply $(d, e') = 1 = (d', e)$.

But $dd' = ee'$ and $(d, e') = 1$, hence $d \mid e$, and

$dd' = ee'$ with $(d', e) = 1$ implies $e \mid d$. Therefore we have $d = e$ and $d' = e'$. This proves our assertion.

Hence there are exactly twice as many zeros in a period as there are pairs of complementary unitary divisors of n. That is, the number of zeros in a period is equal to the number of unitary divisors of n, and this number is easily seen to be $2^{\theta(n)}$. This proves the theorem.

Theorem 4·2 : If n is an even integer, then there are exactly $2^{\theta(n)}$ zeros in a period of the T-sequence mod n.

Proof : Since n is even, the length of the period is $2n$ and we note thate $n \mid T_k$ if and only if $2n \mid k(k+1)$. The proof continues on the same lines as the last theorem. We get that the number of zeros is $2^{\theta(2n)}$. But as n is even, $\theta(2n) = \theta(n)$. This completes the proof.

Summary

In this paper, we have proved that the sequence of triangular numbers mod n is periodic with period n or $2n$ according as n is odd or even. We also prove that a complete residue system mod n exists in the sequence of triangular numbers if and only if n is a power of 2. Finally, we prove that the number of zeros in a period of the sequence of triangular numbers mod n is $2^{\theta(n)}$, where $\theta(n)$ is the number of distinct prime divisors of n.

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SOME CONGRUENCE PROPERTIES OF INDICES

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A positive integer g not exceeding n is called a primitive root of n if $g^k \equiv 1 \pmod{n}$ implies that $\phi(n)$ divides k. Here $\phi(n)$ is Euler's function. It is well known [1, p. 107] that n has primitives roots if and only if $n = 2$, 4, p^α or $2p^\alpha$ where p is an odd prime and α a positive integer. It is also known that if n has primitive roots, then it has $\phi(\phi(n))$ primitive roots. If g is a primitive root of n, then every integer prime to n is congruent (mod n) to exactly one of the integers

$$g^0,\ g^1,\ g^2,\ \ldots,\ g^{\phi(n)-1}.$$

If $(a,\ n) = 1$ and $g^u \equiv a \pmod{n}$, than u is called the index of a relative to g and we write $u = Ind_g\, a$ or simply $u = Ind\ a$ if there is no possibility of confusion.

Predictably, indices have properties similar to those of the logarithm function. In this note, we prove some congruence relations satisfied by indices.

Theorem 1 : If g and h are primitive roots of $n = p^\alpha$ or $2p^\alpha$ and d is any divisor of $p-1$ then $Ind_g\, a \equiv Ind_g\, b \pmod{d}$ if and only if $Ind_h\, a \equiv Ind_h\, b \pmod{d}$.

Proof : Let $Ind_g\, a = u$, $Ind_g\, b = v$, $Ind_h\, a = u'$, $Ind_h\, b = v'$.

Then if $u \equiv v \pmod{d}$, then $u = kd + v$, so that

$$g^u = g^{kd+v} = g^{kd} \cdot g^v.$$

Now $g^k \equiv h^m \pmod{n}$, for some m;

also $g^u \equiv h^{u'}$ and $g^v \equiv h^{v'} \pmod{n}$.

Therefore $h^{u'} \equiv h^{md+v'} \pmod{n}$,

or $h^{|u'-v'-md|} \equiv 1 \pmod{n}$,

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Hence $\phi(n)$ divides $u'-v'-md$, i.e.

$$u'-v'-md=t.\ \phi(n)=tp^{\alpha-1}(p-1).$$

Since $d \mid (p-1)$ and $d \mid (md)$, the above equation shows that $d \mid (u'-v')$, i.e. $u' \equiv v' \pmod{d}$.

The converse part follows by symmetry.

Theorem 2: If $n=p^\alpha$ or $2p^\alpha$ and indices are taken relative to any primitive root of n, then $Ind\ a$ and $Ind\ (n-a)$ have the same parity or opposite parity according as $p \equiv 1 \pmod 4$ or $p \equiv -1 \pmod 4$.

Proof: This result is already implicit in the literature. For, we have [**1**, *p*. 113],

$$(2\cdot1)\quad Ind\ (n-a) \equiv \tfrac{1}{2}\phi(n)+Ind\ a \pmod{\phi(n)}.$$

Hence

$$Ind\ (n-a) \equiv \frac{p-1}{2}+Ind\ a \pmod 2$$

from which the theorem trivially follows.

Theorem 3: If $n=p^\alpha$ or $2p^\alpha$, indices are taken relative to any primitive root of n, and if $a_1, a_2, \ldots, a_k$ are the first $k=\frac{1}{2}\phi(p^\alpha)$ positive integers prime to n, then $\{ Ind\ a_i \mid 1 \leqslant i \leqslant k \}$ is a complete residue system (C.R.S.) *mod* k.

Proof: We have from $(2\cdot1)$

$$(3\cdot1)\qquad Ind\ (n-a) \equiv Ind\ a \pmod k.$$

Also from $(2\cdot1)$, we see that either

$$(3\cdot2)\qquad Ind\ a \leqslant k \text{ or } Ind\ (n-a) \leqslant k.$$

Now suppose

$$(3\cdot3)\qquad Ind\ a_i \equiv Ind\ a_j \pmod k,\ i \neq j.$$

It follows from $(3\cdot1)$ and $(3\cdot2)$ that we can fiind b_i and b_j with $b_i=a_i$ or $n-a_i$ and $b_j=a_j$ or $n-a_j$, $b_i \neq b_j$, $Ind\ b_i \leqslant k$, $Ind\ b_j \leqslant k$, $Ind\ b_i \neq Ind\ b_j$ and $Ind\ b_i \equiv Ind\ b_j \pmod k$.

But $0 < |\ Ind\ b_i - Ind\ b_j\ | < k$, hence there is a contradiction, so that $(3\cdot3)$ cannot be true. This proves the theorem.

Corollary: Under the hypotheses of the theorem, if d_i denotes a_i or $n-a_i$ for each i, then $\{ Ind\ d_i \mid 1 \leqslant i \leqslant k \}$ is also a C.R.S. *mod* k.

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Proof: This follows from the theorm and from (3·1).

Summary: In this note, we have proved a congruence relation for indices taken relative to two different primitive roots of n. We have also given a result regarding the relative parity of *Ind* a and *Ind* $(n-a)$. Finally, a C.R S. mod $\frac{1}{2}\phi(n)$ has been obtained in terms of indices relative to a primitive root of n.

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ATMOSPHERIC CORROSION OF METALS IN PATAN (N.G.)

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ABSTRACT

The rates of corrosion of mild steel, zinc and aluminium and the extent of atmospheric pollution have been determined under outdoor conditions of exposures at Patan (N.G.) representing a tropical rural atmosphere. The monthly rates of outdoor corrosion of mild steel, zinc and aluminium vary from 7–572, 2·2–66·4 and 0·4–1·6 mg./sq.dm. respectively; the values for yearly rates being 802–974, 72·6–141·5 and 1·4–3·1 mg./sq.dm. Aluminium or aluminium coated sheets would, therefore, give better performance in comparison to mild steel or zinc.

At normal temperatures, dry air does not have a corroding effect on metals[1,2]. However, in presence of large amounts of water vapour in the atmosphere, corrosion takes place and it is governed by the principle of critical humidity developed by Vernon[3] and supported by Hudson[4], Patterson[5,6] and Bengough and Whitby[7]. According to this principle, for every metal there is a critical relative humidity below which the rate of corrosion will be very low but above which it will be relatively high. Some metals, e.g., iron, exhibit a secondary critical humidity[5] which is higher than the first. The critical humidity varies with the metal, e.g., 70% for copper[8], 70% for nickel[9], 60 and 80% for iron[9] and 80% for aluminium[10].

As corrosion is an electrochemical phenomenon, the presence of moisture on a metallic surface is one of the most important criteria that determines the corrosion rate[11]. The mechanism of atmospheric corrosion may be considered to be that of a form of immersed corrosion with an unlimited supply of oxygen. If the product of corrosion is a non hydrolysable salt, the extent of corrosion will be determined by the supply of corrosive reagent. When this is unlimited and the corrosion product is

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insoluble, it may protect the metal, because in the case of many industrial metals, the anodic reaction of metal ionization proceeds very slowly in thin layers[12].

Thus the durability of the metallic structures and the protective methods applied to safeguard them from deterioration, depend, to a large extent, on the nature and corrosivity of the atmosphere. In U.S.A., U.K. and other European countries, the corrosivity of various sites has been systematically studied[13–19]. In India, data regarding the relative corrosivity of atmospheres at Delhi[20] (urban), Kanpur[21] (semi industrial), Karaikudi[22] (tropical rural), Bombay[23] (industrial cum marine), Mandapam camp[24] (tropical marine), Calcutta[25] (industrial), Madras[26] (industrial marine), Cochin[27] (marine), Jamshedpur[28] (industrial) and Bhavnagar[29] (tropical marine) are now available. The present communication gives an account of the results obtained at Patan (long., 72·1°E; lat., 23·8° N; 270 ft. above M.S.L.), a tropical rural site in North Gujarat. The metallic panels and the sulphur dioxide as well as chloride candles were exposed on the roof of an outhouse slightly away from the railway station. The rainfall figures for the last ten years at Patan are as follows :

Year	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Rainfall (cm)	127·7	41·8	57·4	122·7	32·8	78·4	48·4	99·8	50·6	46·4
Rainy days	62	29	42	57	33	53	31	36	38	26

The site is thus characterised by low rainfall, low average humidities, high temperature with greater fluctuations in diurnal temperature and rural atmosphere. The winds, especially in the months of May and June, carry sandy particles at fairly moderate velocities.

Experimental

Mild steel and zinc specimens used in the investigation were supplied by the Corrosion Advisory Bureau of the Metals Committee, Jamshedpur, while the aluminium panels were supplied

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by M/s. Jeewanlal (1929) Ltd. The details about the coupons are as follows:

Mild steel: 15 cms. × 10 cms. × 18 s.w.g.; I.S.S. 1079, Gr. 1; C–0·5% max., Mn–0·5% max. S and P–0·05% max.

Zinc : 15 cms. × 10 cms. × 18 s.w.g.; I.S.: 209–1956 (Gr. Zn 99·95%); Zn–min. 99·95%, Pb–max. 0·03%, Cd–max. 0·02%, Iron–max. 0·01%.

Aluminium: 12·5 cms. × 8 cms. × 22 s.w.g.; Commercial 2S, soft temper, I.S.S. 21 : 1959 (SIC Aluminium).

The mild steel specimens were freed from mil scale by the use of Clerke's solution. The specimens were then prepared for the tests according to the method described earlier[30]. The specimens were exposed facing south at an angle of 45° to the horizontal. Every exposure was carried out in duplicate and the mean of the two values, which did not differ by ten per cent, was considered. The corrosion product on mild steel specimens was removed by immersion in Clerke's[31] solution, care being taken to maintain an excess of stannous chloride in solution. The corrosion product on aluminium[32] was removed by concentrated nitric acid, while that on zinc[33] was removed by dipping in chloride and sulphate free ten per cent chromic acid at 50° to 60° for 1 to 5 minutes. For this purpose Stroud's[34] method was modified and barium carbonate was added instead of strontium nitrate. Control specimens were used to determine the loss of metal in the cleaning solution and the final figures of the loss in weight of exposed specimens were corrected accordingly.

In order to ascertain whether the yearly rate of corrosion is influenced by the seasonal conditions prevailing at the time of initial exposure, fresh sets of panels were exposed in each successive month for a period of two years. To study the effect of prolonged exposure on aluminium, about 74 panels were exposed

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in October 1963 and two were removed every month. The results are represented in figures I–III and Tables I–II.

The wet candle method described by Ambler[15] was employed for the determination of salinity of the atmosphere, while the sulphur dioxide content was determined following the method evolved by the 'Fuel Research Institute', U.K.[35] The temperature and humidity were recorded by the use of Negretti and Magarat thermohygrograph, while the rainfall data were collected from the local authorities. The meteorological and atmospheric pollution data are given in figure I and Table I.

Results and Discussion

Meteorological and Pollution data:

The temperature data recorded during the period of study show that generally April, May and June are the hot months of the year, May being the hottest (av. max. temp. about 40°), whereas during December to February, the temperature remains low and varies between 10 to 13°. The fluctuations in diurnal temperature are observed to a greater extent during February to April–May and October to December. The average monthly maximum humidity remains high (c. 90 per cent) during June to September and low during March to May. The maximum, mean and minimum humidities at Patan are higher than the critical humidity value (c. 60%) for iron, for 6 to 12, 3 to 4 and 1 to 2 months respectively in a year. Because of the low humidity of the atmosphere, there are only a few dew days, eventhough the diurnal fluctuations in temperature are high. The average rainfall at Patan is about 70·6 cm. and is distributed over about 3 months of the season, with an average of 41 rainy days. Generally the rains start in June or July and continue up to September.

The average figures for sulphur dioxide and salinity in the atmosphere are 2 mg. SO_3/dm²/month and 16 mg. NaCl/dm.²/month respectively for the period October 1963 to February 1966. The sulphur dioxide content is high in May as well as

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February while the salinity is more in the months of May and June.

Corrosion of Ferrous and non-Ferrous metals :

The skyward surface of the aluminium panels appears dull, while the lower side remains as bright as before in the beginning and tarnishes after a prolonged exposure, but unlike the Kandla tests no conspicuous pitting is observed. The upper surface of the zinc panels when examined under the microscope (× 50), before cleaning, appears tarnished and uneven because of a large number of small pits wherein whitish corrosion product has collected. The lower surface shows lesser number of pits, the attacked portion being covered with a whitish product. With increase in time of exposure, the size of the spot increases Following a Liesegang ring type pattern. The corrosion products and the deposited dust particles are washed down during the rains.

Mild steel specimens, exposed in the wet months, initially develop a reddish yellow corrosion product which turns brown and then black on prolonged exposure. The lower surface of the specimens when examined under the microscope (× 50), appears to be covered with a large number of bubble-like structures of corrosion products. Wherever this structure has ruptured fresh corrosion products have come out. The whole of the structure then appears like a coral stem with buds at the ends having some bright crystalline, multicoloured (bright yellowish-brown to bluish-green) products embedded in them. The upper side of the specimens exposed in the dry months develops numerous pits, smaller in size than those on the lower side and covered with yellowish-brown products with a grayish tint at some points. The lower side is generally covered with a granular deposit and the specimens exposed for longer periods always develop a large (about one inch) blackish gray spot. Here, the product is more adherent, difficult to remove with a knife and on its removal the surface reveals large pits. The rust formed during the rainy season is always loose while that in other months is more adherent.

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In the case of aluminium, the corrosion loss is very little but the weight increment figures are always about 10 to 15 times high, probably due to deposition of dust particles. The monthly corrosion curve follows the humidity curve more closely than the salinity and pollution curves. The corrosion appears to have stopped after the very first month of exposure. The results agree well with a previous report that aluminium and aluminium alloys are highly resistant to normal outdoor exposure conditions and that the rate of attack greatly decreases with increase in the time of exposure due to a self stopping action.[36]

The corrosion of zinc, although more than aluminium, is much less than that of mild steel; the yearly corrosion rate of zinc (c.125 mg./sq.dm./year) being about 1/7th of that of mild steel. Zinc is having a low rate of corrosion (2·6 to 5·8 mg./sq.dm.) during September to May while the rate is high during June to August. The monthly corrosion rate curve for zinc does not follow closely any of the curves of factors affecting corrosion. The progressive weight loss figures (Table II) indicate that if the specimens are exposed in rainless months, the weight loss is lower and the low valve persists till the rains start, whenafter the corrosion suddenly increases. In the case of specimens exposed in the rainy months, the initial weight loss figures are high but the yearly rates are almost of the same order. Here also, the weight increment figures remain high till the deposit is washed out to some extent by the rains, after which the values are lower than the weight loss figures. The weight loss figures also suggest that the degree of rainfall controls the corrosion to a major extent, e.g., specimens successively exposed in August, September and October 1964 and removed on first of August 1965 show almost the same loss in weight, viz., 118·7, 138·6 and 129·1 mg./sq.dm. respectively. The higher values of the yearly rate of corrosion as compared to the summation of monthly rates indicate that the corrosion product slightly accelerates corrosion. This is not the case with mild steel or aluminium exposed at Patan.

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In the case of mild steel, the results (Fig. II, Table II) indicate that initially the weight increment is more than the loss due to corrosion; after three months both the values are almost equal and than the weight loss figures are higher than the weight increment figures, indicating that surface deposit may also be playing some role. As there is no heavy rainfall and as there are less chances for the formation of soluble chlorides and sulphates of iron, the weight increment figures always remain positive and almost constant during the later part of the year of exposure. Eventhough the corrosion rates for different months vary widely, the total corrosion during the year is almost of the same order, irrespective of the month of exposure. This may be attributed to low degree of pollution. The extent of corrosion increases with time, the increase being more during the wet months; the yearly corrosion lossal most remains constant which shows that most of the corrosion takes place during the period July to September, especially during the first two months of the rainy season. The results show that during the dry months, because of low humidity as well as low salinity and pollution, the panels do not corrode much and, therefore, there are no chances for them of being covered with a non-porous protective film. In the absence of such a protective film or if the film formed is less thick, uneven and porous, the panels show high corrosion only during rainy months (irrespective of the month of initial exposure) and hence almost the same yearly rates of corrosion.

The non-resemblance of the corrosion and salinity curves shows that the low degree of salinity has very little effect on corrosion of mild steel. Similarly, the absence of any relationship between the temperature and atmospheric corrosion of mild steel, indicates that the corrosion is controlled more by other factors rather than temperature alone. The monthly corrosion rates are highest during the rainy months (June to September) but are not proportional to the amount of rainfall, as the corrosion is influenced by the period of wetness and humidity rather than the amount of total rainfall, other conditions

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remaining the same. As reported by Rajagopalan et al,[26] low amount of sulphur dioxide may have slight protective value and therefore in the present case slight increase or decrease in sulphur dioxide content of the atmosphere may not have affected the corrosion of mild steel to a greater extent. Also, the dust particles which settle down on the metal surface do not appear to accelerate corrosion to a greater extent because of the low humidity and also probably because of their inert nature. The constancy of corrosion loss after rainy season clearly indicates that rainfall and humidity are the chief controlling factors of corrosion in places like Patan. The above findings are also supported by the experiments in which zinc panels are exposed to the atmosphere with the lower surface waxed. This was done in July 1965 when there was heavy rain and also some pollution. The results show that 90% of the corrosion takes place on the upper side which is directly exposed to rain. It is only when the rainfall and humidity values are high or when all, i.e., temperature, humidity, salinity and sulphur dioxide pollution values are high, there is an increase in corrosion. At values of humidity lower than critical, the corrosion of mild steel is almost of the same order (less than 20 mg./sq.dm. when R. H. is less than 55%).

Conclusion

The maximum humidity remains above the critical value for iron (c. 60%) almost throughout the year, but the mean humidity is higher than critical only during the wet months of the year. The extent of atmospheric pollution is very low, the average values being 2·0 mg.SO_3/sq.dm./month and 16·0 mg. of NaCl/sq.dm./month.

The monthly rates of outdoor corrosion vary from 7 to 572, 2·2 to 66·4 and 0·4 to 1·6 mg./sq.dm. for mild steel, zinc and aluminium respectively, the values being high during the period June to September. The values are highest in the month in which the rainfall is maximum. The yearly rates of corrosion vary between 802 to 974, 72 to 141·5 and 1·4 to 3·1 mg./sq.dm.

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for mild steel, zinc and aluminium respectively. The yearly rates do not depend upon the initial period of exposure, although the monthly figures may differ widely. On an average, the corrosion of aluminium is about 3/1000th and that of zinc about 1/7th of that of mild steel. Thus aluminium or aluminium coated sheets would give better performance in comparison to mild steel or zinc.

The results show that in atmospheres with a very low degree of pollution and relatively lower humidities, the corrosion is controlled mainly by the number of rainy days and the amount of rainfall in the first instance followed by the average humidity values, sulphur dioxide pollution and salinity values. Thus the pattern of corrosion at a rural site is determined by weather conditions only and the local factors play a part in determining the actual rate of corrosion.

On plotting the corrosion rates (loss of metal) during different months against the factors which influence corrosion, no correlation appears to exist all over the period of study, between the corrosion and any of the factor taken singly, although during some parts of the year, the curves do follow each other.

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TABLE I

Average Humidity and Rainfall Data at Patan (1963–1966)

Month	*Av. relative humidity %*			*Rainfall mm.*	*No. of rainy days*
	Min.	*Max.*	*Mean.*		
October *1963*	34·1	71·3	52·7	6	1
November	35·0	72·7	53·9	22	2
December	44·7	65·0	54·9	—	—
January *1964*	38·6	57·4	48·0	—	—
February	44·0	57·3	50·7	—	—
March	28·4	51·7	40·1	—	—
April	28·2	61·1	44·7	—	—
May	29·2	68·8	49·0	—	—
June	40·2	73·8	57·0	108	6
July	52·7	75·9	64·3	169	15
August	66·5	88·4	77·5	197	17
September	53·1	89·6	71·4	—	—
October	35·2	74·7	55·0	—	—
November	36·7	70·0	55·4	—	—
December	35·7	69·7	52·7	—	—
January *1965*	41·1	80·9	61·0	42	2
February	31·6	70·6	51·1	—	—
March	27·5	62·5	45·0	—	—
April	43·1	66·6	46·9	—	—
May	31·2	72·6	51·9	22	2
June	40·0	86·0	63·0	—	—
July	62·4	89·5	76·0	307	17
August	52·0	88·2	70·1	59	4
September	46·0	87·7	66·9	34	1
October	33·3	77·0	55·2	—	—
November	38·4	76·3	57·4	—	—
December	38·4	73·8	56·1	—	—
January *1966*	37·2	71·5	54·3	—	—
February	33·6	71·0	52·3	—	—

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TABLE II

Corrosion (mg./sq. dm.) of Different Metals under outdoor exposure conditions at Patan (N.G.)
(Figures in the Parenthesis indicate weight Increment before Cleaning)

Month of Exposure	*Exposure Period (Months)*												
	1	2	3	4	5	6	7	8	9	10	11	12	
(a) Zinc :													
July 1964	22·9	30·3	34·0	35·6	38·7	41·3	43·2	45·0	46·1	46·8	48·4	72·6	
	(16·0)	(26·0)	(26·8)	(33·6)	(34·7)	(31·7)	(27·4)	(32·8)	(34·4)	(32·6)	(35·6)	(67·2)	
Aug. 1964	20·0	24·6	27·2	33·4	34·3	38·7	39·1	40·0	40·8	42·5	48·8	118·7	
	(18·0)	(18·6)	(37·7)	(32·7)	(34·6)	(26·3)	(34·3)	(29·0)	(33·1)	(17·3)	(59·6)	(74·4)	
Sept. 1964	5·8	6·3	6·9	10·0	12·8	13·1	13·8	14·4	14·9	45·2	138·6	141·5	
	(8·8)	(22·5)	(24·8)	(36·0)	(14·9)	(21·0)	(19·9)	(18·0)	(9·8)	(66·6)	(99·0)	(112·0)	
Oct. 1964	4·7	6·0	6·7	8·1	9·3	10·3	10·7	11·1	44·3	129·1	130·1	134·3	(99·3)
Nov. 1964	4·8	—	—	—	—	—	—	39·3	122·7	—	—	137·3	(112·2)
Dec. 1964	3·8	—	—	—	—	—	37·8	125·1	127·0	128·8	131·0	131·5	(122·6)
Jan. 1965	5·5	—	—	—	—	36·2	95·0	115·7	119·5	—	—	126·9	(117·9)
Feb. 1965	2·6	—	—	—	33·9	122·0	128·7	—	129·3	—	—	130·7	
	(13·9)	—	—	—	(62·3)	(94·3)	(114·4)	—	(96·6)	—	—	(103·1)	
(b) Mild steel :													
Jan. 1965	14·0	24·0	37·0	78·0	155·0	544·0	635·0	771·0	789·0	805·0	810·0	814·0	
	(16·2)	(32·2)	(62·5	(77·3)	(138·9)	(358·9)	(417·1)	(456·8)	(474·3)	(469·3)	(449·1)	(433·5)	
Feb. 1965	9·0	—	—	—	—	629·0	756·0	781·0	794·0	—	—	802·0	
	(11·0)	—	—	—	—	(492·0)	(595·3)	(460·3)	(771·1)	—	—	(734·0)	
(c) Aluminium :													
Oct. 1963	0·4	0·45	0·9	0·95 (15·1)	1·1 (11·3)	1·15 (10·4)	1·2 (11·3)	1·4 (33·9)	1·5 (6·8)	1·55 (7·9)	1·9 (10·8)	1·95 (8·5)	

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13	14	15	16	17	18	19	20	21	22	23	24	
2·0 (9·6)	2·05 (11·4)	2·1 (21·5)	2·15 (11·4)	2·15 (11·6)	2·2 (14·5)	2·2 (14·0)	2·25 (14·1)	2·8 (33·5)	3·75 (20·0)	4·0 (28·8)	4·1 (27·5)	
25	26	27	28	29	30	31	32	33	34	35	36	37
4·2 (38·7)	4·3 (39·1)	4·35 (45·1)	4·35 (57·0)	4·4 (51·6)	4·5 (54·4)	4·8 (49·8)	5·0 (58·2)	5·8 (53·6)	6·3 (47·5)	6·7 (48·3)	6·8 (54·6)	7·2 (63·0)

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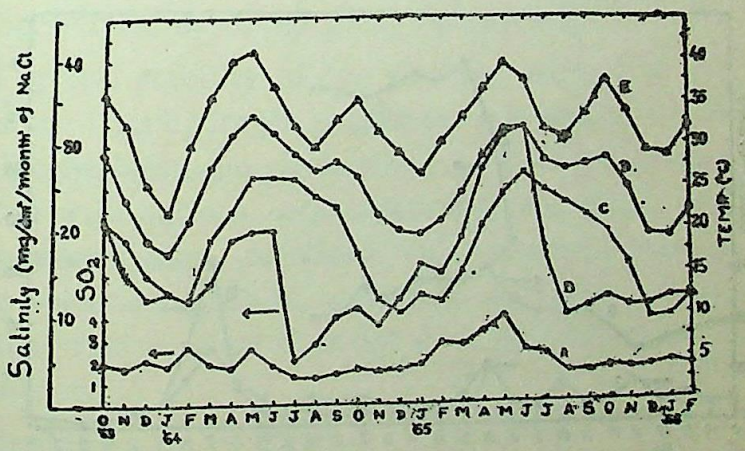

Fig. I : Temperature, salinity and sulphur dioxide content of Patan atmosphere : (*a*) Sulphur dioxide (mg. SO_3/sq. dm./month), (*b*) salinity (mg. NaCl/sq.dm./month), (*c*) av. minimum, (*d*) av. mean, and (*e*) av. maximum temperature.

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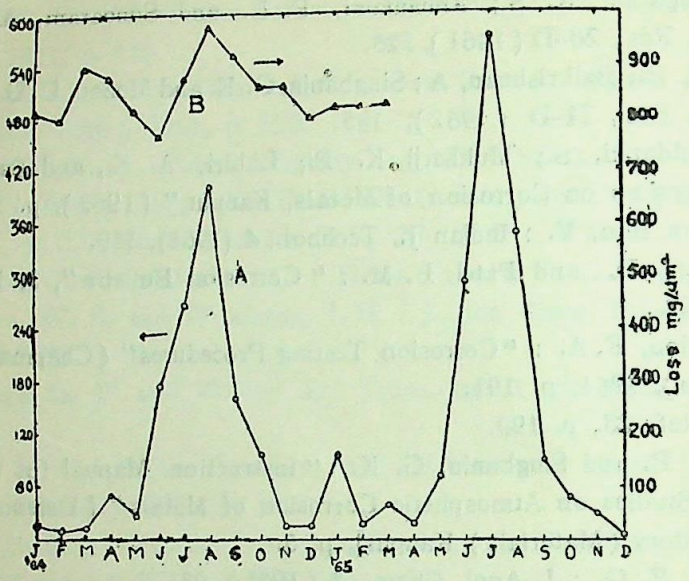

Fig. II : Monthly and yearly rates of corrosion of mild steel under outdoor exposures during different months. : (*a*) Monthly rate, (*b*) Yearly rate.

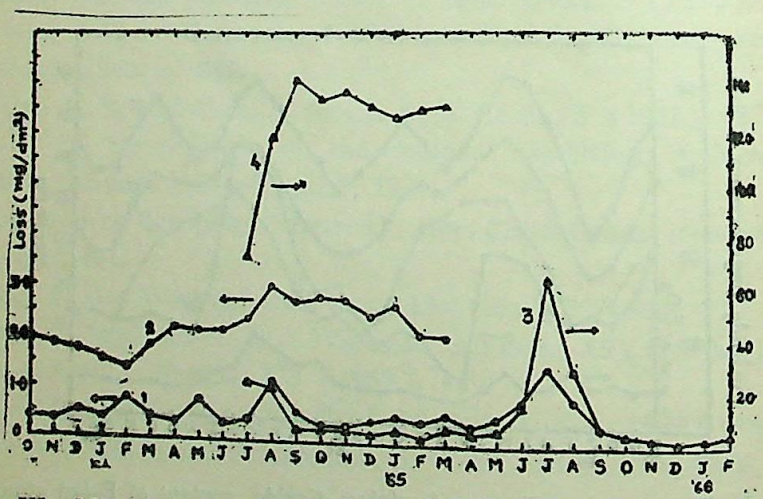

Fig. III : Monthly and yearly rates of corrosion of Zinc and Aluminium under outdoor exposures during different months. : (1) Monthly rates–aluminium, (2) Yearly rates-aluminium, (3) Monthly rates–Zinc, (4) Yearly rates–Zinc.

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THE OPTICAL STABILITY OF TETRAHYDRO-2-NAPHTHOL CONTRASTED WITH OPTICAL LABILITY OF TETRA-HYDRO-2-NAPHTHYLAMINE

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Pope and Harvey[1] resolved the compound 1 : 2 : 3 : 4-tetrahydro-2-Naphthylamine but found that on resolution of the compound from its active salts, partial racemisation occurred. Later on this investigation was undertaken by Davies, Edwin and Kenyon[2] who resolved ac-1 : 2 : 3 : 4-tetrahydro-2-naphthylamine as its hydrogen tartarate from equimolecular amounts of the base and (+)-tartaric acid and confirmed the lability of the active amine. In an attempt to throw more light on this unexpected behaviour the structurally related 1 : 2 : 3 : 4-tetrahydro-2-naphthol has been resolved[3] and examined by us. In marked contrast to the lability of the amine, the alcohol and its derivatives exhibited great optical stability.

The optical stability of the alcohol, resolved through the brucine salt of its hydrogen phthalate, was studied by hydrolysing the active hydrogen phthalate of 1 : 2 : 3 : 4-2-tetrahydro-2-naphthol with various concentration of the alkali, and alkyl- or acyl-oxygen fission reactions with common reagents like sodium p-toluene sulphinate, formation of the neutral ester, etc., showed that this carbinal does not show monomolecular heterolysis tendency.

Experimental :

Preparation of (±)-1 : 2 : 3 : 4-2-tetrahydro-2-naphthol :

This alcohol was prepared by the method *of* Bemberger and Lodter[4] by the reduction of β-naphthol in amyl alcohol with sodium; b.p. 138-44/20 mm.

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Preparation of its (±)-H.P. :

The alcohol (1M) was added to phthalic anhydride (1M) dissolved in pyridine (1·1M) in benzene (100 c.c.). The mixture was heated for 4 hours and the product decomposed with ice and hydrochloric acid, extracted with ether, washed, dried and on evaporation, the hydrogen phthalate of 1 : 2 : 3 : 4–tetrahydro-2–naphthol was obtained as white plates, m.p. 84–86.

Found by rapid titration with NaOH, Neut. Equi. 311; $C_{18}H_{16}O_5$ required Neut Equi., 312.

Preparation of (+) and (−)-1 : 2 : 3 : 4–tetrahydro–2–Naphthol :

The (±)-H.P. (1M) was dissolved in hot acetone (200 c.c.) to which was added brucine alkaloid (1M) and the clear mixture was allowed to keep at the room temperature for 2 days when the less soluble brucine salt was crystallised out. This on six recrystallisations and decomposition gave optically active (+)−hydrogen phthalate, $[\alpha]_D^{32}+13\cdot95$, the more soluble fraction on concentration and decomposition gave the other isomer, (−)-H.P. $[\alpha]_D^{32}-13\cdot13$. The (+) and (−) –H.P. on hydrolysis with alkali and extraction with ether gave (+) and (−)- −1 : 2 : 3 : 4–tetrahydro–2–naphthol, $[\alpha]_D^{32}$ (+) and (−)–67·1 respectively.

Hydrolysis to study the Stability :

The (±)–H.P. (0·5 g.) was hydrolysed with various concentrations of alkali (NaOH) in water and also with aqueous sodium carbonate. The (+) –alcohol was recovered with the same optical rotation. No racemisation took place.

Attempts to prepare Sulphone :

The (−)–H.P. $[\alpha]_D^{32}-13\cdot10$ (0·2 M) was added to sodium p–toluene sulphinate (0·2 M) in acetic acid and a few drops of concentrated sulphuric acid. On keeping the mixture for several days no sulphone formation took place, indicating that no alkyl-oxygen fission has taken place. The active H.P. was recovered unchanged.

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Attempts to prepare neutral ester :

The active H.P. (0·2M) was dissolved in sodium hydroxide (0·15 N; 10 c.c.) and kept at room temperature overnight. No turbidity appeared on long standing and the H.P. was recovered indicating the non-formation of neutral ester, i.e., no monomolecular heterolysis took place.

Attempts to racemise the active carbinol :

The active carbinol, $[\alpha]_D^{32} + 67 \cdot 0$ (0·5 g.) was shaken with hydrochloric acid for 6 hours. No racemisation took place and (+) –alcohol with the same optical activity was recovered.

The authors are thankful to Gujarat University for providing research facilities and the Ministry of Education for providing grants for chemicals.

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EVALUATION OF EXCHANGEABLE CATIONS IN SALINE SOILS

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It has been agreed by workers on saline soils that exact determination of exchangeable cations is difficult, specially in saline-alkali soils. Saline soils may contain, besides sodium salts, high proportion of calcium carbonate, magnesium carbonate, gypsum, and immature clay minerals. Many alternative procedures, for determining exchangeable cations have been suggested by Kellner (1887), Kelley and Brown (1925), Hissink (1924), Puri (1936), Tjurin (1927), Mehlich (1942), Bower and Truog (1940) and others.[1–9] It appears, it may not be possible to suggest a single method for all types of soils; and suitable modifications will have to be devised for specific types of soils.

The difficulties encountered in determining cations that are exchanged may be due to the following factors:

(1) Variation in solubility of calcium carbonate, magnesium carbonate, etc., in different extracting solutions,
(2) The effect of water : soil ratio on the nature and extent of extraction of different salts,
(3) Influence of pH on extraction,
(4) Influence of nature of clay minerals on extraction.

Exchangeable cations were determined in our laboratories, following U.S.D.A. procedures.[10] The procedure incorporates various determinations:

(*a*) An aliquot portion of the soil is extracted with a requisite quantity of water by 'saturation extract method'. This is utilised to determine water soluble salts.

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(*b*) Another portion of the soil is treated with *N* ammonium acetate solution. This is utilised to determine water soluble plus exchangeable sodium and potassium. Exchangeable sodium and potassium can be obtained by deducting respective values of individual cations in '*a*' from those in '*b*'.

(*c*) Total exchange capacity is determined by 'sodium acetate method'.

According to the procedure suggested by U.S.D.A., if all the procedures are satisfactory,

$c = b - a$ (for total exchangeable cations).

Calcium and magnesium in exchangeable cations are determined by deducting exchangeable sodium and potassium from total exchange capacity.

Two types of errors were evident in the above determination during the course of our investigation.[11] In some cases, values of exchangeable sodium far exceeded the total exchange capacity. In some other cases, values of exchangeable sodium were found to be negative. Sodium and potassium were determined following the procedures recommended by the U.S.D.A. Some of the results are presented in tables I–A and I–B.

TABLE I–A

S. No.	*EC × 10³ at 25° C*	*pH*	*Milliequivalents per 100 g. soil*		
			T.E.C.	*K*	*Na*
116-A	2·5	8·7	11·1	1·00	21·2
122-A	182	8·2	21·5	Tr	27·5
127-A	73·6	8·5	25·0	0·80	38·3
315-A	6·0	9·6	15·9	0·75	21·8
241-A	119	8·3	10·9	1·54	17·4

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TABLE I–B

S. No.	EC × 10³ at 25° C	pH	Milliequivalents per 100 g. soil		
			T.E.C.	K	Na
131-A	175	8·6	27·3	Tr	–ve
133-A	140	8·2	12·7	Tr	–ve
136-A	74·4	8·8	25·0	4·6	–ve
137-C	70·0	8·8	28·0	4·2	–ve
118-A	193	8·3	13·9	Tr	–ve
120-A	180	8·3	7·2	Tr	–ve

TABLE I–C

CHEMICAL ANALYSIS OF SATURATION EXTRACT

S. No.	EC × 10³ at 25° C	Melliequivalents per litre							
		Ca	Mg	Na*	K	CO_3	HCO_3	SO_4	Cl
116-A	2·54	6·0	10·0	21·3	Nil	2·0	15·0	Nil	20·0
122-A	182	2120	432	2620	Tr	Tr	7·2	Tr	5200
127-A	73·6	87·4	24·4	886	Tr	Nil	3·4	79·0	916
315-A	6·0	3·0	2·0	49·2	0·4	1·4	11·7	Nil	35·0
241-A	120	56·0	102	1380	1·0	Nil	4·1	238	1470

TABLE I–D

EXCHANGEABLE BASES, CLAY AND CALCIUM CARBONATE CONTENT

S. No.	S.P.	pH	Milliequivalents per 100 g. soil				ESP	Clay %	$CaCO_3$ %
			T.E.C.	Ca + Mg	K	Na			
116-A	110	8·7	11·18	—	Nil	21·2	—	22·0	41·0
122-A	36	8·2	21·58	—	Tr	27·5	—	24·6	51·0
127-A	56	8·5	25·01	—	Nil	38·3	—	18·0	57·5
315-A	137	9·6	15·92	—	Nil	21·8	—	19·2	66·5

Discussion

We shall first consider the case, when exchangeable sodium apparently turns out to be negative (–ve).

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The method presupposes that the total soluble salts, found by the saturation extract, will be the same when the soil is extracted with N-ammonium acetate solution. This may not be the case. When a certain amount of liquid is removed from the saturation paste by pressure, the concentration of salts in the aqueous part within the paste may be less than in the saturation extract obtained. In a set of preliminary experiments, it has been found that extraction by 1:5 soil: water method may be more satisfactory. According to Kelley[5], the influence of pH on mode and extent of extraction will have to be examined more thoroughly. This is so far as the lower or negative values of exchangeable sodium are concerned.

We shall now consider the case when exchangeable sodium value is greater than T.E.C., as stated before:

$$\text{Exch. Na} = b\ (\text{water soluble Na} + \text{Exch. Na}) - a\ (\text{water soluble Na}).$$

The excessive values of exchangeable sodium may be due either to 'b' being too low, or 'a' being too high. It is probable that both the above factors may be operative. The saturation extract contains a very small amount of water and may not dissolve all the salts. Here again experiments with different soil: water ratio and adjustment of pH may help. To compensate for the inadequate solubility of cations, Bower[1] has suggested to determine the chlorine content: (*i*) by saturation extract method, and (*ii*) by analysis of the solution obtained by exhaustive leaching.

The value of soluble cation (sodium) is then obtained by multiplying with the factor:

cl in exhaustive leaching/cl in saturation extract

One or both the types of above anomalies are encountered in saline and alkali soils which are prevalent in many parts of Gujarat. It is obvious that methods of soil analysis need continuous revision.

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THE CHEMICAL ELEMENTS AND THEIR DISCOVERY

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From the dawn of human civilization, philosophers have attempted to gain an understanding of the elements, the fundamental constituents of all matter. Kapila, the originator of Samkhya philosophy, which is regarded as the oldest of the six systems of Hindu philosophy, developed his ideas about the elements. According to him, five subtle particles, which were named as *tanmatras* and are imperceptible to human senses, were derived from the conscious principle, *bhutadi*. These gave rise to the five *bhutas* or elements, which were : (*i*) *akasa* (space or ether), (*ii*) *vayu* (air), (*iii*) *tejas* (fire), (*iv*) *ap* (water) and (*v*) *kshiti* (earth). These *bhutas*, of course, should not be confused with the elementary substances, but they are in reality five abstract principles or a classification of substances, on the basis of their properties and states of aggregation. For example, earth, water and air may be regarded as elements; *kshiti* typifying all solids, *ap* all liquids and *vayu* all gases. The Greek theory of elements introduced by Empedocles (490–430 B.C.) has a great resemblance to the atomic theory of the Samkhya system. The Greek philosopher, Democritus (470–360 B.C.) gave the atomic hypothesis which has many points in common with the views of Kanada, the founder of the Vaiseshika system of Indian philosophy. Almost identical views have been expressed in the Nyaya system of Hindu philosophy.

With the progress of the scientific method, the above concept of an element as applied to matter had to undergo profound changes. According to modern ideas, a chemical element is one of over a hundred different substances, which

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cannot themselves be decomposed by chemical means and which alone or in combination constitute all matter. They are composed of mainly three fundamental particles : (*i*) proton, (*ii*) neutron, and (*iii*) electron. The first two particles constitute the nucleus and are responsible for the mass of the atom. The electrons move outside the nucleus in different orbits, known as the energy levels. The various elements are distinguished from one another by the number of protons, which is also equal to the number of electrons outside the atomic nucleus. This number is known as the atomic number. Elements corresponding to all atomic numbers from 1 to 92, except 85 and 87 are known to occur in nature. The total number of chemical elements now known is 104, of which ninety are natural and the rest have been obtained by man. The latest element to be discovered is No. 104, which has been reported in 1964. The elements which have been obtained artificially are element numbers 43 (Te), 61 (Pr), 85 (At), 87 (Fr), 93 (Np), 94 (Pu), 95 (Am), 96 (Cm), 97 (Bk), 98 (Cf), 99 (Em), 100 (Fm), 101 (Md), 102 (No), 103 (Lw) and 104 (?). Also, many naturally occurring elements and their isotopes have been obtained.

The discovery of the chemical elements, is one of the most fascinating chapters in the study of chemistry and is also of interest to students of the history of science. The chemical elements have abundantly contributed to the progress of human civilization and the material blessings which we enjoy today have resulted largely from our knowledge of the chemical elements. For example, in the ancient buildings of the Great Mughals we may see a lavish display of marble staircases, alabaster floors, mosaic ceilings, or excellent specimens of stone carvings, but no nickel or chromium. Golden vessels and objects are abundantly found in the ancient pyramids, but we do not see any objects made of platinum or tantalum. The bravest conquerer of the medieval age could not have even a tiny palette of aluminium with all the spoils of his wars.

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The mightest of the ancient rulers had to be earth-bound, because no light metal like aluminium or magnesium or no light gas like hydrogen or helium was known to make lofty flights possible. While walking at night, a lantern had to be carried with him, because no tungsten was known, to have incandascent bulbs, or no neon was known to furnish coloured light. The water available for drinking was often a menace to civic health, since no chlorine or flourine were known to disinfect it and to kill the bacteria. In the battlefield, the bravest general had to lie helpless when wounded, because no iodine was available to heal his wounds or oxygen to ease the breathing of the gasping warrior.

It will, therefore, be interesting to know how the various chemical elements have been discover one by one and this will not only be an interesting story but will also throw light on their chemical behaviour.

From the Hindu scriptures and the Hebrew literature as well as from the writings of Pliny the Elder (23–79 A.D.) we come to know that the metals gold, silver, copper, lead, tin, mercury and iron were know to the ancients. The known non-metals of that time were sulphur and carbon. Obviously, this is because these non-metals occur free in nature and these metals occur in the native state or because their metallurgical operations were not complicated. Incidentally, mercury which was easy to obtain, attracted the attention of early people because it is a mobile liquid. The ancient Hindus attributed mystic qualities to this metal. Gold fascinated people because of its attractive yellow colour. Golden vessels and specimens of fine brocades have been found in the Egyptian tombs.

In the Alchemic period, the main aim was the preparation of gold from the base metals. The terminology of the alchemists was obscure, but it is definite that they knew about arsenic, antimony, bismuth and phosphorous. The existence of phosphorus in plants and in the bones of animals was established in the seventeenth century.

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The eighteenth century saw the discovery of zinc, cobalt, nickel and manganese. The search for copper in new minerals led to the discovery of cobalt and nickel.

People wanted to know the composition of water and air which resulted in the discovery of oxygen by Priestly (1774). Scheele had discovered it earlier, but his results were published three years later in 1777. Hydrogen was discovered by Cavendish and nitrogen by Rutherford (uncle of Sir WalterScott).

Among the other metals which were discovered in the eighteenth century were chromium, molybdenum, tungsten, uranium, tellurium and selenium. These were followed by niobium, tantalum and vanadium during the next hundred years.

Platinum was discovered in the eighteenth century but the other metals of the platinum family were discovered in the next century. The use of platinum was not known for many years and it was employed for adulterating gold.

The production of electric current in the earlier years of the nineteenth century, caused a revolution in science and in human civilization itself. The alkali metals and the alkaline earths were for the first time produced by electrolysis of their fused chlorides. The electropositive nature of the alkali metals was later employed in the discovery of zirconium, titanium, cerium, thorium, beryllium, boron, silicon and aluminium by a displacement of these elements from their compounds by the alkali metals.

The design of the spectroscope in the later half of the nineteenth century led to the discovery of helium, cesium, rubidium and indium.

The year 1869 was very significant in chemical science, because Mendeleef enunciated the periodic law in this year. The gaps in the periodic table offered a great impetus to the search for new elements and gallium, scandium and germanium were discovered.

The element numbers 58–71 are known as the rare-earths and the story of their discovery spread over the eighteenth,

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nineteenth and the twentieth centuries, which in itself is a long and fascinating chapter. It was due to researches of Moseley (1914) that the total number of the rare-earth elements and their characterization was made possible.

The four common halogen elements, chlorine, bromine, iodine and fluorine were discovered respectively by Scheele, Lowing, Courtois and Moissan. Chlorine was discovered in the eighteenth century while the others in the nineteenth century.

The discovery of the inert gases of the atmosphere during the closing years of the nineteenth century and the beginning of the present century was due to the great experimental skill of Lord Rayleigh, Ramsay and their associates. The total amount of these gases in the atmosphere is only one per cent and their discovery illustrates the painstaking and devoted endeavours by the workers for their characterization.

Researches on radium by Madam Curie and her husband and the discovery of radioactivity opened new avenues, which ultimately led to the synthesis of the transuranic elements, responsible for the development of the atomic energy.

The discovery of elements shows the endeavour of man to conquer nature and we have yet to see what further achievements are attained in this direction.

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THE INFRARED AND ULTRAVIOLET SPECTRA OF SOME SULPHONYL HYDRAZIDES AND SULPHONYL HYDRAZONES

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The preparation of hydrazone derivatives of several aryl/thienyl sulphonyl hydrazides has been described by Munshi and Trivedi[1]. As part of a study of their physical properties, we have investigated the ultraviolet spectra of some sulphonyl hydrazides and infrared spectra of these and some related compounds, containing either of the groupings $-SO_2NHNH_2$ or $-SO_2NHN=CH-$ in order to identify these groups by their characteristic frequencies.

The ultraviolet absorption spectra of various aryl sulphonyl hydrazides were studied in 95% ethanol using a Unicam (model SP–500), spectrophotometer. The infrared absorption spectra of sulphonyl hydrazides and hydrazones were recorded on a Perkin-Elmer double beem spectrometer (model 21–C, Infracord) with sodium chloride prism.

Procedure for UV :

The sample, 0·001 mole was dissolved in 100 ml. of 95% ethanol. The solution thus obtained was used for obtaining the spectraphotometer readings. The wave-lengths are recorded in milimicrons and the intensities in terms of the logarithms of the molar extinction coefficients.

For Infrared :

The sample about 15 mgms. was mulled in a drop or two of nujol for ten minutes. The spectra were taken over the range 2–15 microns using an automatic slit-drive and a

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scanning rate of thirty minutes. The compounds and the frequencies observed for the N-H and S-O stretching vibrations are discussed below. The intensities are indicated by the following symbols; s – Strong; m – Medium; w – Weak; vw – Very weak. The absorption frequencies are in K units (cm^{-1}).

Discussion :

The ultraviolet absorption curves of aryl sulphonyl hydrazides are composed of two bands *A* and *B*.

The curve of benzenesulphonyl hydrazides shows bands at λ_{max} 267 mμ (log E_{max} 3·2) as primary *A* band and λ_{max} 274 mμ (log E_{max} 3·08) as a secondary *B* band. The benzenesulphonyl hydrazone of benzaldehyde shows an intense main band *A* at λ_{max} 272·5 mμ thus showing a bathochromic shift because of the substitution of polyenic system.

p-Methoxybenzene sulphonyl hydrazide shows a primary band *A* at λ_{max} 270 mμ (log E_{max} 3·2) and a secondary weak bands *B* at λ_{max} 274 mμ (log E_{max} 3·1) and λ_{max} 280 mμ (log E_{max} 2·95). As compared to this, the data available for benzenesulphonyl hydrazone of p-methoxy-benzaldehyde[2] shows bands at λ_{max} 280 mμ (log E_{max} 4·3) a considerable bathochromic shift because of substitution of a polyenic system in the molecule.

p-Chlorobenzene sulphonyl hydrazide shows a primary band *A* at λ_{max} 264 mμ (log E_{max} 3·1) and a *B* band at λ_{max} 268 mμ (log E_{max} 3·0) with a very weak secondary band at λ_{max} 280 mμ (log E_{max} 2·5); while in p-bromobenzene sulphonyl hydrazide λ_{max} 280 mμ is the only absorption shown. p-Methylbenzene sulphonyl hydrazide absorbs in the region λ_{max} 265 mμ (log E_{max} 2·68) as a primary *A* band and λ_{max} 270 mμ (log E_{max} 2·68) as a secondary *B* band.

Broadly speaking it can be seen that as we go from benzenesulphonyl hydrazide to the nuclearly substituted derivatives there is a slow diminitions of the band *A* and *B* and in p-bromobenzene sulphonyl hydrazide there remains only one

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band. The primary absorption band *A* finally disappears completely, in the following order :

$$p\text{-}CH_3O > p\text{-}Cl > p\text{-}H > p\text{-}CH_3 > p\text{-}Br.$$

N–H stretching vibrations :

All the sulphonyl hydrazones show a single N–H stretching frequency in the infrared range (3125–3333 cm^{-1}). The sulphonyl hydrazides contain an additional NH_2 group and in consequence show more bands in the N–H stretching region.

S–O stretching vibrations :

The asymmetric and symmetric vibrations of the $>SO_2$ groups appear near (1302 – 1383 cm^{-1}) and (1124 – 1193 cm^{-1}) respectively. In the sulphonyl hydrazones, these bands are always of slightly higher frequency than in the corresponding parent sulphonyl hydrazides.

Other bands :

All phenyl as well as thienyl sulphonyl hydrazides and hydrazones invariably show medium to strong absorption peaks in the region 1653–1470 cm^{-1}, this is the region assigned for the NH deformation and conjugated C=N stretching vibrations. The δNH_2 group of hydrazine is also known to absorb in the region 1613 cm^{-1}. Sulphones are known to absorb in the region 1300–1350 cm^{-1} and 1140–1160 cm^{-1} strongly[3]. The region 1140–1180 and 1300–1360 cm^{-1} is also assigned to the group $-SO_2N-$ in the sulphonamides by Adams and Tjepkema[4]. All compounds studied in this work show strong to medium absorption in the region 1300–1380 cm^{-1} and 1111–1250 cm^{-1}. It may be possibly the characteristic region for the $-SO_2NHN-$ group; since the region 1020–1220 cm^{-1} is also assigned for aliphatic type amines by Colthup[5].

Thienyl sulphonyl hydrazones show a distinct absorption band in the region 833–870 cm^{-1} characteristic of thiophene. A medium or fairly strong band is found in the range 923–937 cm^{-1} in the spectra of aryl sulphonyl hydrazones but none was noticed in the sulphonyl hydrazides examined.

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Further a typical strong band is observed in the region 3876-3984 cm^{-1} in sulphonyl hydrazones.

It is thus clear that the absorption due to the sulphonyl hydrazine group $-SO_2NHN-$ is in the region 1111-1380 cm^{-1}.

Experimental

I. Various sulphonyl hydrazides have been synthesised by the action of hydrazine hydrate (50%, 0·1 mole) on sulphonyl chlorides (0·05 mole) in benzene (25 ml.)[6].

1. Benzenesulphonyl hydrazide crystallised from chloroform mp. 102°C (Borsche and Frank[7] report mp. 102·4°C; Witte[8] reports mp. 104°C).

   λ_{max}^{EtOH} 267 mμ (log E_{max} 3·2); 274 mμ (log E_{max} 3·08).

   ν_{max}^{NaCl} 3390w, 3279m (NH-stretching); 1575w (NH-deformation); 1471s, 1418s, 1376m, 1339m, 1302s (S-O stretching); 1299m, 1156s (S-O stretching); 1069m.

2. p-Toluene-sulphonyl hydrazide crystallised from chloroform mp. 112°C (Albert and Royer[6] report mp. 112°C).

   λ_{max}^{EtOH} 265 mμ (log E_{max} 2·68); 270 mμ (log E_{max} 2·68).

   ν_{max}^{NaCl} 3390m, 3311w (NH stretching); 1600m (NH deformation); 1475s, 1383w, 1351m, 1316m, 1309s (S-O stretching), 1170w, 1163m, 1157s (S-O stretching), 1031m, 1010m.

3. p-Anisyl-sulphonyl hydrazide crystallised from ethanol, mp. 99°C (Abernethy et al[9] report mp. 108°C, solvent EtOH; H_2O 1 : 1).

   λ_{max}^{EtOH} 270 mμ (log E_{max} 3·2); 274 mμ (log E_{max} 3·11).

   ν_{max}^{NaCl} 3356m (NH stretching); 3030s; 1592m (NH deformation); 1493s, 1408s, 1316m (S-O stretching); 1258w, 1156m (S-O stretching); 1089w.

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4. p-Chlorobenzene-sulphonyl hydrazide crystallised from ethanol mp. 128°C (Abernethy et al[9] report mp. 115°C decomp. crystallised from butanol).

λ_{max}^{EtOH} 264 mμ (log E_{max} 3·1); 268 mμ (log E_{max} 3·0) 280 mμ (log E_{max} 2·50).

5. p-Bromobenzene sulphonyl hydrazide crystallised from ethanol mp. 155°C (Abernethy et al[9] report mp. 122°C crystallised from butanol).

λ_{max}^{EtOH} 280 mμ (log E_{max} 3·05).

ν_{max}^{NaCl} 3378w, 3333m (NH stretching), 3030m, 1567m (NH deformation), 1481w, 1389w, 1323s (S-O stretching), 1274m, 1160s (S-O stretching); 1099m, 1064s, 1010s.

6. 2-Nitrothiophene-4-sulphonyl hydrazide hydrochloride.... To 2-nitrothiophene-4-sulphonyl chloride (0·05 mole) dissolved in benzene (25 ml.) in a 250 ml. round bottom flask, hydrazine hydrate (50% 0·1 mole) was added dropwise. The reaction mixture was then poured over crushed ice; extracted with three 30 ml. portions of ether; ethereal layer separated and dried over anhydrous $MgSO_4$. The dry ethereal extract was filtered and the filtrate collected into a conical flask. Hydrogen chloride gas was passed into it till saturated. On evaporation of ether a crystalline colourless solid began to separate. It was obtained in platelets from hot ethanol mp. 141°C. Yield 54%.
(Found : N, 16·1%; S, 24·3%, $C_4H_6ClN_3O_4S_2$ requires N, 16·2%; S, 24·7%).

ν_{max}^{NaCl} 3390w, 3333m (NH- stretching), 2740m, 1575w (NH deformation), 1471m, 1408m, 1379w, 1340; 1316m (S-O stretching), 1198m, 1149m (S-O stretching), 1126w, 870m, 847m.

II. Various sulphonyl hydrazones have been prepared by refluxing equimolar proportions of sulphonyl hydrazide and aldehyde in ethanol in presence of fused sodium acetate.

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$R-SO_2NH-N=CHR_1$

Sr. No.	*R=*	*R_1=*
1.	2-thienyl	p-$CH_3O \cdot C_6H_4$
2.	2-thienyl	2, 4-$Cl_2C_6H_3$
3.	2-chloro-5-thienyl	4, 3 (OH) (CH_3O) C_6H_3
4.	2-chloro-5-thienyl	3, 4-$CH_2O_2C_6H_3$
5.	2-chloro-5-thienyl	α-$C_{10}H_7$
6.	2-Bromo-5-thienyl	p-$OH \cdot C_6H_4$
7.	2-Bromo-5-thienyl	4, 3 (OH) (CH_3O) C_6H_3
8.	2-Bromo-5-thienyl	α-$C_{10}H_7$
9.	p-CH_3O-C_6H_4	o-OH-C_6H_4
10.	p-CH_3O-C_6H_4	α-$C_{10}H_7$

1. 2-Thienyl sulphonyl hydrazone of anisaldehyde-pale yellow needles from ethanol mp. 170-1°C; yield 58%.
(Found : N-9·2% and S-21·5% $C_{12}H_{12}N_2O_3S_2$ requires N-9·5% and S-21·6%).

ν_{max}^{NaCl} 1625m, 1613s, 1504s, 1460s, 1325m, 1300s (S-O stretching), 1250s, 1176s, 1160s (S-O stretching), 1111m, 970m, 870m, 833s.

2. 2-Thienyl sulphonyl hydrazone of 2, 4-dichlorobenzaldehyde-colourless needles from ethanol mp. 91°C, yield 56%.
(Found : N-8·1% and S-18·8% $C_{11}H_8Cl_2N_2O_2S_2$ requires N-8·4% and S-19·1%).

ν_{max}^{NaCl} 3226s, 1639w, 1610w, 1563m, 1504s, 1466s, 1374m (S-O stretching), 1258m, 1120s (S-O stretching), 1096s, 970s, 870w.

3. 2-Chloro-5-thienyl sulphonyl hydrazone of vanillin-orange needles from ethanol, mp. 154°C, yield 63%.
(Found : N-7·9% and S-18·5% $C_{12}H_{11}ClN_2O_4S_2$ requires N-8·1% and S-18·5%).

ν_{max}^{NaCl} 1653s, 1608s, 1575m, 1515s, 1383w, 1348m, 1304s (S-O stretching), 1274m, 1182m, 1170m, 1149s (S-O stretching), 1134w, 976m, 870m, 847m.

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4. 2-Chloro-5-thienyl sulphonyl hydrazone of piperonal-yellow needles from ethanol, mp. 198-9°C, yield 56%.

(Found : N-8·0% and S-18·3% $C_{12}H_9ClN_2O_4S_2$ requires N-8·1% and S-18·6%).

ν_{max}^{NaCl} 3226m, 1639m, 1613m, 1504s, 1480m, 1449s, 1385m, 1366m (S-O stretching), 1312w, 1258s, 1198s, 1126s (S-O stretching), 1100s, 970m, 870m.

5. 2-Chloro-5-thienyl sulphonyl hydrazone of α-naphthaldehyde-orange yellow needles from ethanol, mp. 147°C, yield 65%.

(Found : N-8·0% and S-18·0% $C_{15}H_{11}ClN_2O_2S_2$ requires N-8·0% and S-18·3%).

ν_{max}^{NaCl} 1639w, 1613s, 1515w, 1493w, 1466s, 1379m, 1351m, 1333s (S-O stretching), 1235s, 1168m (S-O stretching), 1100m, 976w, 877m, 870w.

6. 2-Bromo-5-thienyl sulphonyl hydrazone of p-hydroxybenzaldehyde colourless needles from ethanol, mp. 88°C, yield 56%.

(Found : N-7·7% and S-17·5% $C_{11}H_9BrN_2O_3S_2$ requires N-7·8% and S-17·7%).

ν_{max}^{NaCl} 3226s, 1653w, 1613w, 1563m, 1508s, 1471m, 1383s (S-O stretching), 1255m, 1124s (S-O stretching), 1094s, 970s, 865w, 846w.

7. 2-Bromo-5-thienyl sulphonyl hydrazone of vanillin-orange needles from ethanol, mp. 169-71°C, yield 60%.

(Found : N-7·0% and S-16·4% $C_{12}H_{11}BrN_2O_4S_2$ requires N-7·2% and S-16·4%).

ν_{max}^{NaCl} 3226m, 1647w, 1608m, 1563m, 1508m, 1453s, 1383s, 1312s (S-O stretching), 1253m, 1170w, 1149w, 1124s (S-O stretching), 1096s, 970s, 866w, 846w.

8. 2-Bromo-5-thienyl sulphonyl hydrazone of α-naphthaldehyde-orange yellow needles from ethanol, mp. 156-7°C, yield 62%.

(Found : N-7·0% and S-16·0% $C_{15}H_{11}BrN_2O_2S_2$ requires N-7·1% and S-16·2%).

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ν_{max}^{NaCl} 1639w, 1613s, 1515w, 1471s, 1389m, 1355s, 1333s (S–O stretching), 1238s, 1170s, 1143s (S–O stretching), 1111w, 980w, 877m, 866w.

9. p–Anisyl sulphonyl hydrazone of salicylaldehyde–pale yellow hairlike needles from ethanol, mp. 215°C, yield 52%.
(Found : N–8·9% and S–10·3% $C_{14}H_{14}N_2O_4S$ requires N–9·1% and S–10·5%).

ν_{max}^{NaCl} 1631s, 1582m, 1493m, 1460w, 1389m, 1333s, 1316s (S–O stretching), 1279s, 1241w, 1205m, 1198w, 1163s, 1149s (S–O stretching), 1117m.

10. p–Anisyl sulphonyl hydrazone of α–naphthaldehyde–golden yellow needles from ethanol, mp. 147°C, yield 64%.
(Found : N–8·0% and S–9·4% $C_{18}H_{16}N_2O_3S$ requires N–8·2% and S–9·4%).

ν_{max}^{NaCl} 1613s, 1515w, 1471s, 1379m, 1355s, 1333s (S–O stretching), 1235s, 1214w, 1170s (S–O stretching), 1143w.

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SYNTHESIS OF 3-THIOXO-5-OXO-1, 2, 4-TRIAZINES

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Summary

A series of substituted 3-thioxo-5-oxo-1,2,4-triazine have been synthesised, in order to investigate their physiological activities.

Cattelain (Bull. Soc. Chem., France **11**, 273, 1944; Compt. rend., **210**, 763, 1940) studied the reaction between ∝-ketoacid and thiosemicarbazide and reported the formation of 3-thioxo-5-oxo-1, 2, 4-triazines. This author also reported the formation of triazine from the condensation of phenyl pyruvic acid with 2, 4-dimethyl thiosemicarbazide (**12**, 139, 1945).

Tisler (J. Org. Chem., **25**, 770, 1960) investigated this reaction and reported that it was not necessary to isolate the intermediate 4-aryl thiosemicarbazone of the ∝-oxo acids, since a direct cyclisation was effected in alkaline medium. A recent paper by Ueda and Watanabe (Chem. Abstr., 1964, 8032) confirms the above findings.

We have investigated this reaction further with phenyl pyruvic acid and several 4-alkyl/aryl/aralkyl/cycloalkyl thiosemicarbazide and have observed that the products obtained directly are the 1, 2, 4-triazines, presumably through the intermediate formation of thiosemicarbazones. These compounds are described in the table.

Experimental

Phenyl pyruvic acid was prepared from acetyl glycine through an intermediate compound, ∝-acetamino cinnamic acid, according to Herbst and Shemin (Organic Synthesis, Coll. Vol. II, page 519, John Wiley, 1963).

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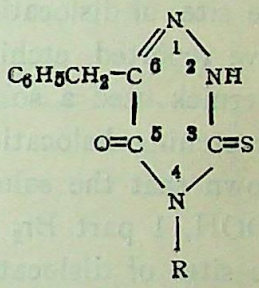
Synthesis of the triazine compounds : Phenyl pyruvic acid (1·0 mol.) and 4-alkyl/aryl/aralkyl/cycloalkyl thiosemicarbazide (1·0 mol.) were taken in ethanol and refluxed over a water bath for a period of eight hours. The contents were poured in water and the precipitated product collected at the pump with several washings of cold water. The crude product was crystallised from ethanol until a reasonably pure product (found analytically) was obtained. One crystallisation was found generally enough in most of the cases.

TABLE

3-THIOXO-5-OXO-2, 3, 4, 5-TETRAHYDRO-1, 2, 4-TRIAZINES



No.	R=	M.P. °C	Mol. Formula	%Sulphur Calcd.	%Sulphur Found
1.	n-butyl	187	$C_{14}H_{17}N_3OS$	11·6	11·4
2.	n-amyl	110	$C_{15}H_{19}N_3OS$	11·1	10·9
3.	n-hexyl	92	$C_{16}H_{21}N_3OS$	10·6	10·6
4.	cyclohexyl**	66-68	$C_{16}H_{19}N_3OS$	10·6	10·4
5.	phenyl	55-57	$C_{16}H_{13}N_3OS$	10·8	10·6
6.	o-tolyl	162	$C_{17}H_{15}N_3OS$	10·4	10·1
7.	m-tolyl	80	do	10·4	10·2
8.	p-tolyl	165	do	10·4	10·1
9.	o-anisyl	76-78	$C_{17}H_{15}N_3O_2S$	9·8	9·7
10.	p-anisyl	65	do	9·8	9·7
11.	p-chlorophenyl	75	$C_{16}H_{12}ClN_3OS$	9·7	9·6
12.	p-iodophenyl**	82-85	$C_{16}H_{12}IN_3OS$	7·6	7·3
13.	benzyl	190	$C_{17}H_{15}N_3OS$	10·4	10·2

** Requires two recrystallizations to obtain pure product.

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DISLOCATION ETCH PITS IN COPPER

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Introduction

Chemical etching has been extensively used for revealing the sites of dislocations in metals. Various workers 1, 2, 3, 4, 5 have reported etching of single crystals of copper. Lovell and Wernick used a solution containing $FeCl_3$, HCl, HAC and Br_2 for etching dislocation on (111) face of copper. Livingston[2] has shown that the solution containing 25 parts HCl, 15 parts CH_3 COOH, 1 part Br_2 and 90 parts water is capable of revealing the sites of dislocations on the (111) face of copper. We have developed a new etchant in the laboratory and comparative study of the etch patterns produced on the (111) face of copper single crystal by etching the crystal in the etchant developed by us and that of the Livingston is reported here.

Experimental

Single crystals of copper (99·99% pure) cut along the (111) plane were used in the present work. The crystals were in the form of disc about 1 cm. radius and 0·2 cms. thickness. They were electropolished in the laboratory by usual method. After several trials, the solution containing 50% orthophosphoric acid in water was found suitable for electropolishing of the crystals. The experimental arrangement employed for electropolishing is shown in the diagram.

The polishing solution was taken in a beaker which was placed in a large vessel containing water. The specimen was made anode and a thick plate of stainless steel was used as a

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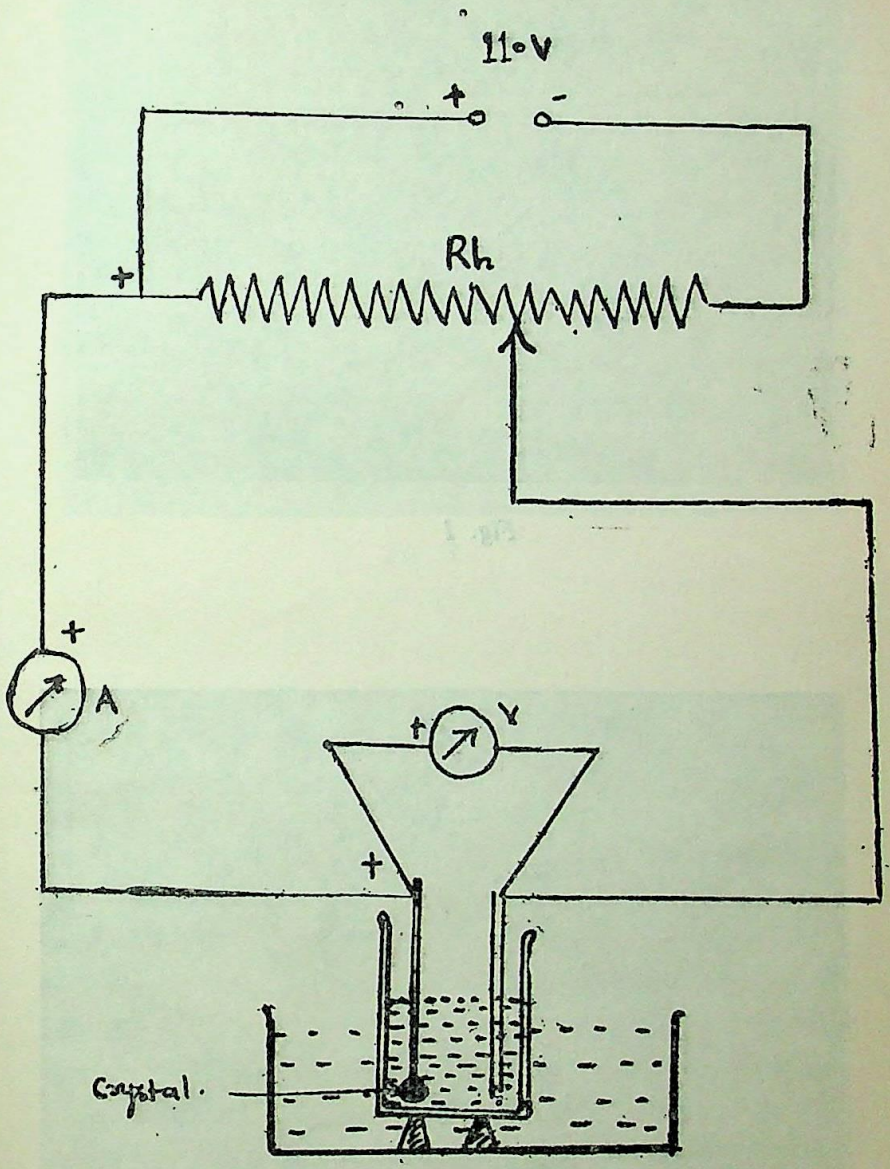
cathode. A direct current of 0·55 amperes and a cell voltage 2 volts was found satisfactory for the best polishing of the specimen. In about 15 minutes, the polishing of the specimen



was found satisfactory. The electropolishing was followed by water rinse and then immersion in alcohol. The resulting surface of specimen obtained was highly polished and plane. The specimen was then subjected to etching and etch pattern was studied by using Olympus Metallurgical Microscope.

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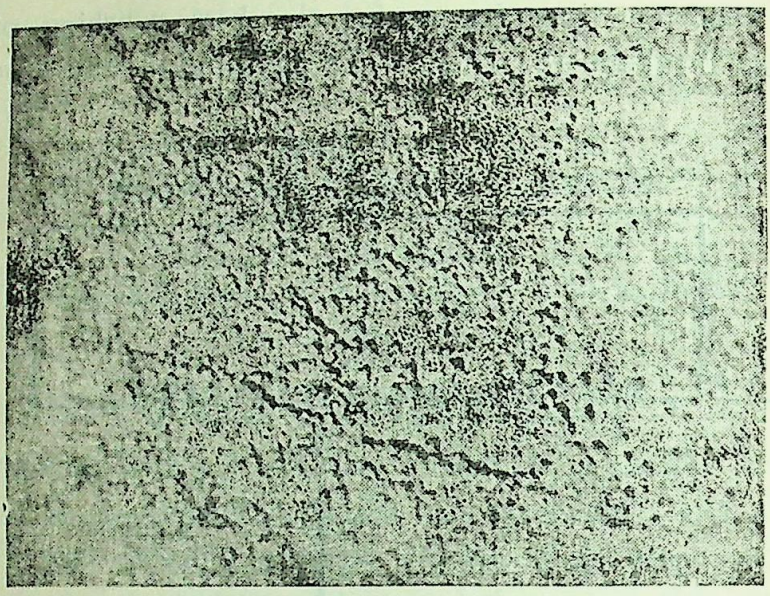

Fig. 1

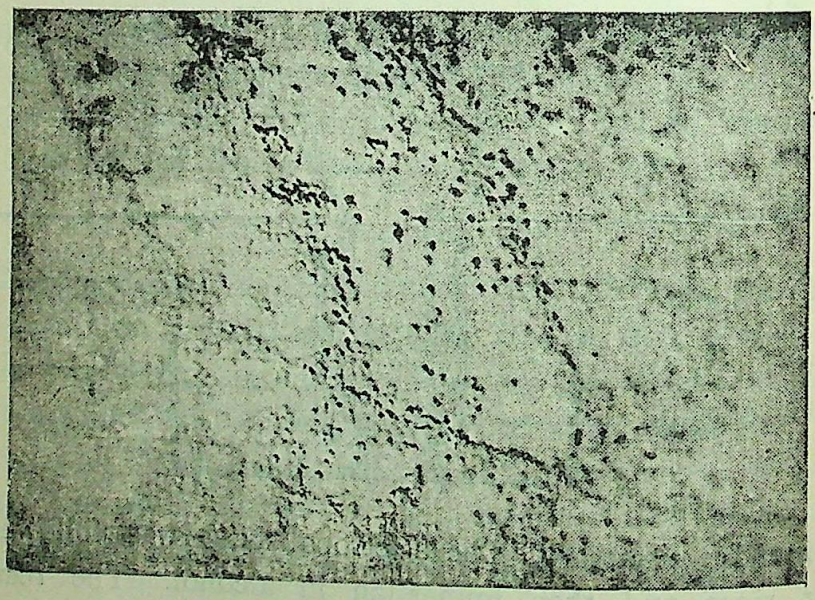

Fig. 2

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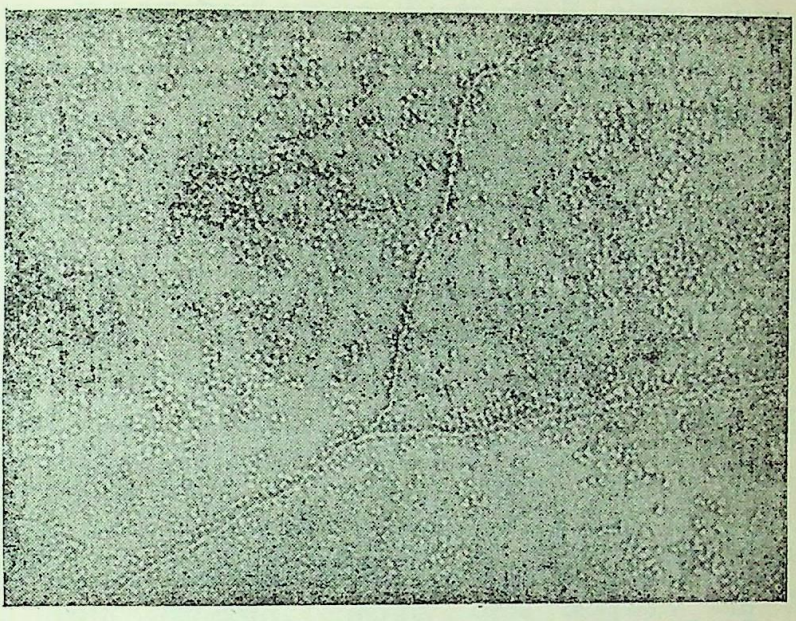

Fig. 3

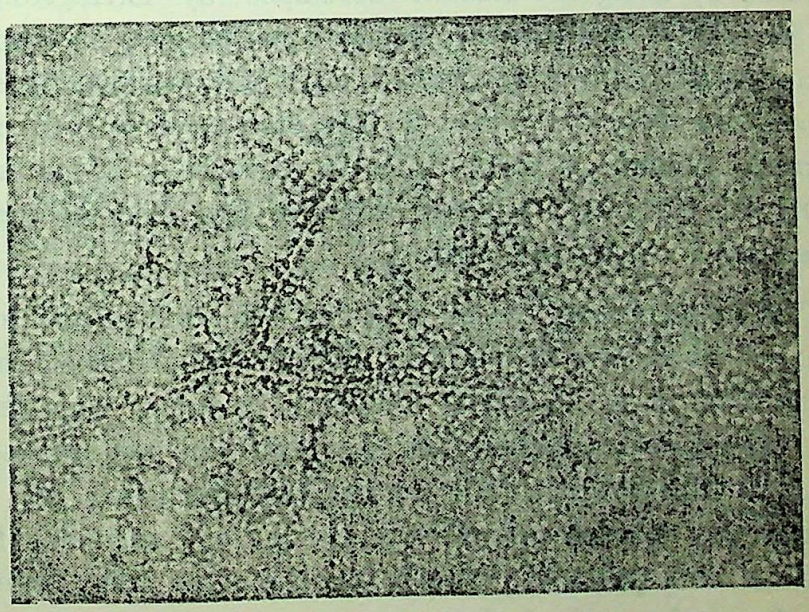

Fig. 4

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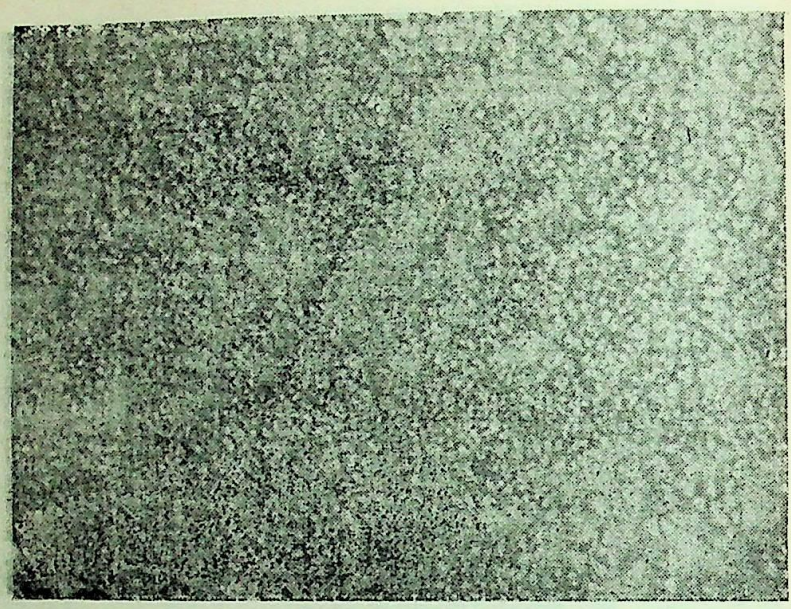

Fig. 5

Results

In the present work, a comparative study of the etch patterns produced by using the etchant developed by Livingston and that developed in our laboratory is reported. We shall call the etchant developed by Livingston as etchant 1 and that developed in this laboratory as etchant 2. The etchant developed in this laboratory contains 5 parts $FeCl_3$, 25 parts HCl, 25 parts CH_3COOH, 50 parts H_2O and few drops of Br_2. The etching was carried out at room temperature.

The electropolish crystal was first subjected to etching in etchant 1 which was followed by water rinse and then immersion in alcohol fig. 1 shows the etch patterns obtained on the (111) face after etching the specimen for ten seconds in etchant 1. The specimen was again electropolished and then subjected to etching in etchant 2 for four seconds. fig. 2 shows the etch patterns produced on the same area, shown in fig. 1. It can be noticed that at most of the places there is a point to point correspondence between the etch pits of fig. (1) and fig. (2).

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The growth of etch pits with increasing time was also studied in the present work fig. (3), (4) and (5) show the etch patterns on the same area after etching the crystals successively for 3 sec., 6 sec. and 9 sec. respectively in etchant 2. It is seen that with increasing time the number of pits practically remains the same and the pits size increase.

When the concentration of the etchant is decreased the etch rate decreases.

Conclusion

Correspondence between etch pits at most of the places produced by etchant 1 and 2 show that the etchant developed in this laboratory is capable of revealing the sites of dislocations in copper. Moreover, the pits grow in size and not in number with increasing etching time supports the above conclusion.

Acknowledgements

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STUDIES IN THE ANATOMY OF THE CYPERACEAE–I

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The anatomical information on the Cyperaceae, a notoriously difficult family (Metcalfe, 1964) is limited only to a handful of publications. As early as 1906, Plowman considered the primitive Cyperaceae to be fresh water forms but d'Almeida and Ramaswamy (1948) proved them to be essentially fresh water plants wearing a xerophytic mask. The numbers and distribution of cell division and cell lengths have been determined for the various tissues in the aerial shoot of *Eleocharis acuta* R. Br. Prodr. (Evans, 1965). In all tissues examined except the plate parenchyma, cell length is inversely correlated with number of cell divisions. The transverse strands connecting adjacent vascular bundles are considered to be important in the conduction of water. In *Eleocharis intermedia* (Albert, 1963) developing metaxylem nuclei go through a series of DNA doublings correlated with nuclear volume doubling and cell volume increases at least up to the 16 or 32-ploid level. Koyama (1965) separated the two tribes Lagenocarpeae and Sclerieae on anatomical observations on leaf blades. Cheadle (1955) observed a gradation from many perforation plates with some of their bars incompletely formed in *Cladium mariscoides* and *C. jamaicense* to a single large perforation plate in the vessels of thirteen genera of the Cyperaceae. The stem of *Lagenocarpus* (Pfeiffer, 1923, 27) exhibits secondary thickening of the type well-known in *Dracaena*. Recently Mani (1957, 63, 64) noted a transition from a concentric vascular bundle of the rhizome to a collateral one in the inflorescence taking at their point of attachment

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while Ahuja (1962) studied the epidermis of six sedges. They have missed the earlier works. Mehra and Sharma (1963) described the anatomy of *Eleocharis plantaginea* and Mullan (1945) united *Scirpus grossus* L. and *S. kysoor* Roxb. under the older name *Scirpus grossus* L. by studying its anatomy under dry and wet conditions.

During 1872–74, Duval-Jouve gave an excellent account of silica cells in the Cyperaceae. He observed 'saillies coniques' in the epidermal cells outside the fibre strands in 57 species belonging to 12 genera. Westermaier (1884) and Esenbeck (1914–15) also described similar 'kegelformingen Verdickungen' in the Cyperaceae. Holm (1899 *a*, *b*, *c*) explicitly mentioned 'characteristic siliceous cones' in the epidermis of a number of North American Cyperaceae and Haberlandt (1914) indicated the presence of peculiar strongly silicified conical processes in the Cyperaceae. Chermazone (1926, 1928) noted a 'cone siliceux' in 3 species of *Fimbristylis*. Recently Metcalfe (1961, 1963) has drawn attention to the systematic value of dome shaped silica deposits in the epidermis of the Cyperaceae. In *Mapania wallichii* and *Scirpodendron costatum*, the silica bodies are of an entirely different type for they bridge individual cells in the form of miniature arches so that epidermal cells are vaulted (Metcalfe, 1963) and in certain species of *Chlorizandra*, *Hypolytrum* and *Lepironia* they are absent (Metcalfe, 1963). Mehra and Sharma (1965) have studied the silica cells in 60 sedges and in *Eriophorum comosum*, the silica cells which occur abundantly in both stem and leaf have comparatively large silicified processes. They did not cite the ten forms of 'Kogelzellen' described by Pfeiffer (1921, 1926). He termed them Duval-Jouve silica bodies formed by the absorption of hydrosol silicic acid by cellulose. On the other hand, it is rather surprising that Plowman (1906), Gibbs (1908), Monoyer (1933), d'Almeida and Ramaswamy (1948) and Conway (1936) in their investigations of the Cyperaceae have made no mention of silica cells. Isolated references of the sedges are also scattered in general anatomical treatises of Carlquist (1962), De Bary (1884), Eames and Mac Daniels (1947), Esau

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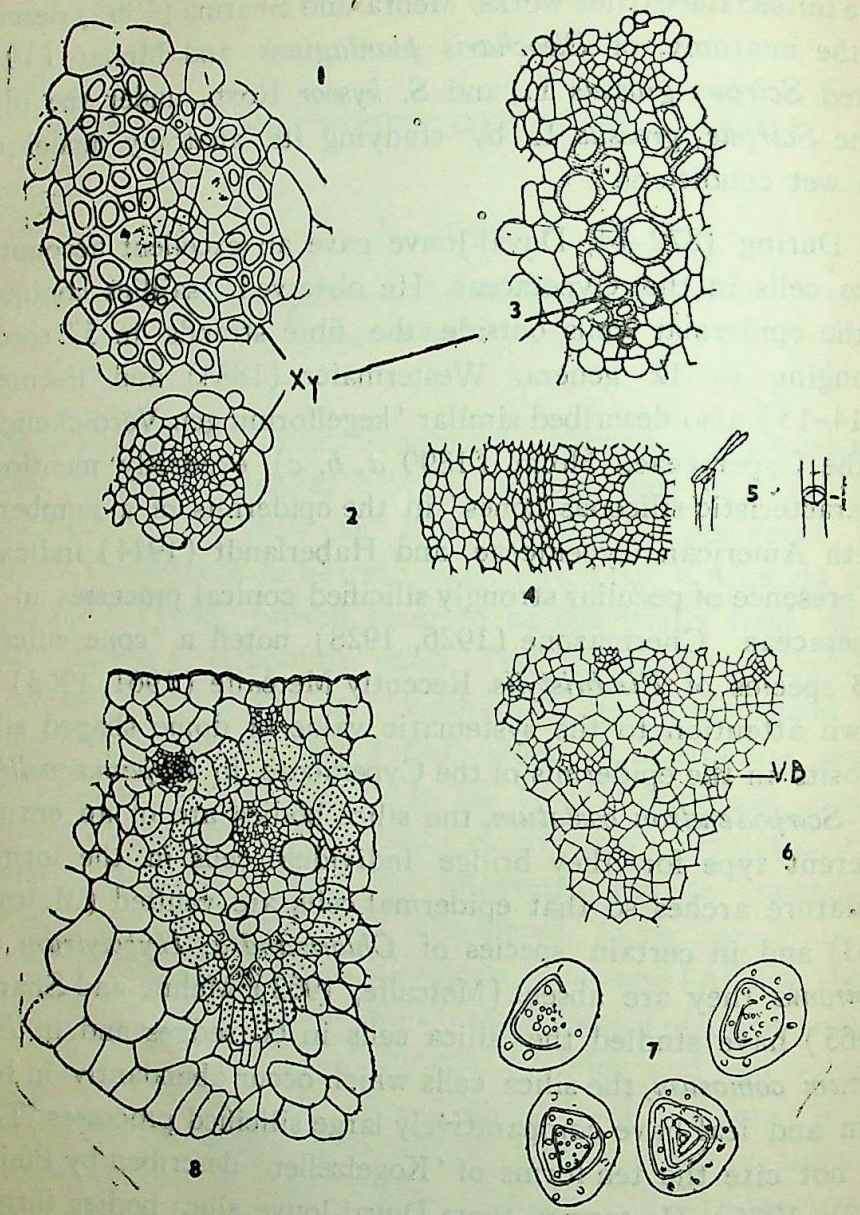

Figs. 1–8: *Cyperus niveus*, Figs. 1–3. T. s. showing totally and partially concentric and a centrivasal vascular bundle from the rhizome × 950. Fig. 4. T. s. young root showing radial files of cells × 820. Fig. 5. Ligule at the junction of the leaf sheath and lamina × 5. Fig. 6. T. s. epicotyl of a young decorticated seedling showing seven conjoint collateral vascular bundles. Fig. 7. Serial transverse sections at the base of the seedling showing the separation of leaves × 150. Fig. 8. T. s. leaf × 950.

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(1959), Foster (1949), Haberlandt (1914), Jeffrey (1917), Stover (1951) and Tobler (1957). The paper describes the anatomy of two sedges, viz., *Cyperus niveus* Retz. and *Kyllinga triceps* Rottb.

Observations

Rhizome: The epidermal cells are tabular and more or less thickened especially on the outer side. Sub-epidermal sclerenchymatous strands form a compact protective covering over the rhizome. Opposite to them, the epidermal cells are correspondingly smaller. There is a well defined endodermis (*Fig.* 19). In *Cyperus niveus* this thick-walled endodermis together with neighbouring cortical cells which also become sclerenchymatous forms a sheath completely cutting off the central cylinder from the outer tissue which dries up and hangs as a loose protective jacket. The inner cortex composed of thin-walled parenchyma is either compactly arranged or has a loose texture or is even lacunar. Thus the cortex is highly susceptible to environment and varies in the same species (Plowman, 1906). In *Kyllinga triceps*, the cortex is 4-5 times larger than the stelar region (*Fig.* 16). Its parenchyma is gorged with starch grains. Thus the nodose bases of the stolon develop into a tuber. In *Cyperus niveus*, the stored material is oil. It emits fragrance when fresh rhizomes are crushed. The vascular bundles are scattered in the central cylinder. Three types of bundles have been observed—amphivasal in the stout rhizomes (*Figs.* 1, 2), centrivasal in elongated ones (*Fig.* 3) and an intermixture with transitions of the two types of bundles in tuberous parts. A very young stem shows centrivasal vascular bundles only (*Fig.* 6). All the vascular bundles are devoid of sclerenchymatous sheaths.

Flowering axis: Within the epidermis is a solid mass of ground tissue whose cells increase in size towards the centre. Only the photosynthetic portions of the ground tissue partly or wholly embrace the vascular bundles. The endodermis is absent. The vascular bundles are scattered in the ground tissue.

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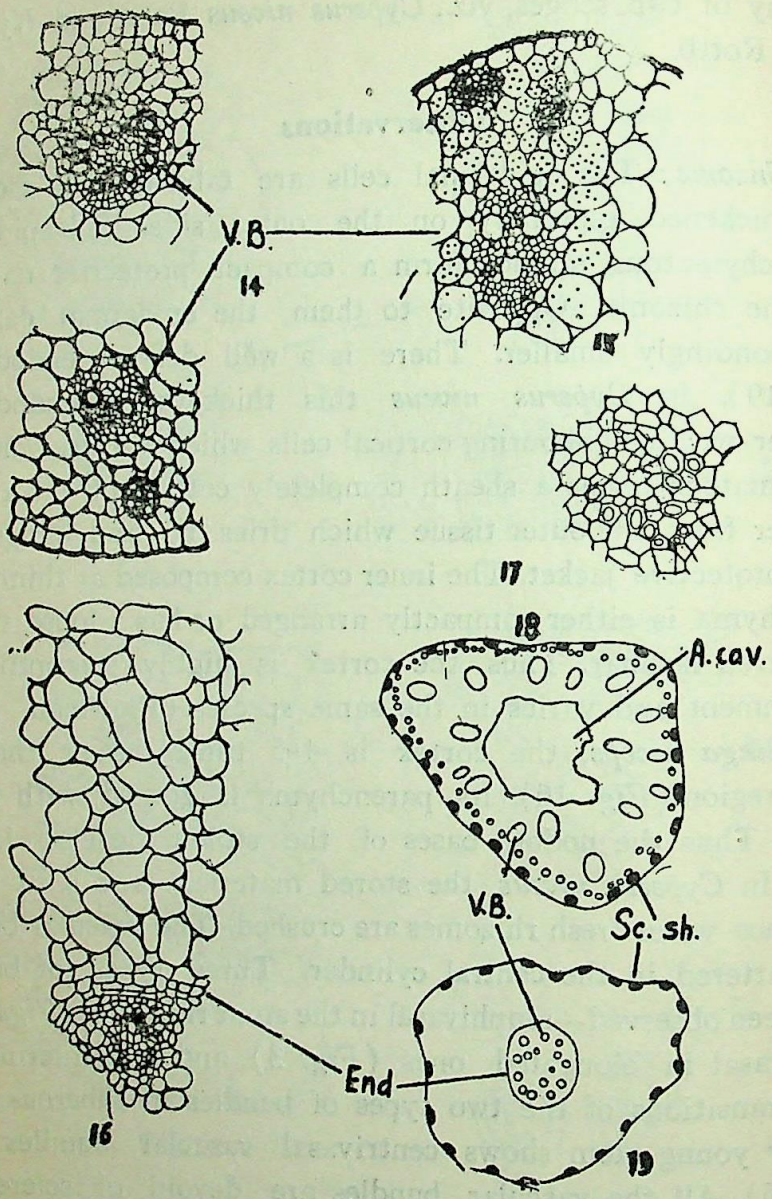

Figs. 14–19: *Kyllinga triceps*. Figs. 14, 15, 17. Portion of T. s. of inflorescence axis showing vascular bundles. Fig. 16. Portion of T. s. of the rhizome showing amphivasal vascular bundle. Fig. 18. T. s. inflorescence axis, diagrammatic × 220. O-vascular bundles, sclerenchyma hatched and a lysigenous cavity. Fig. 19. T. s. rhizome diagrammatic × 220. O-vascular bundles and the sclerenchyma hatched.

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While the rhizome is characterised by the amphivasal type of vascular bundles, the inflorescence axis and the leaves possess closed collateral bundles (*Figs.* 14, 17). In the topmost portion of the flowering axis, the vascular bundles are more numerous and crowded together. The incurrent bundles from the bracts, rays and secondary inflorescence axes form a tangled mass termed as dense nodal complex by Jeffrey (1917). The vascular bundles are numerous and crowded together especially towards the periphery. They are of different sizes. The outer ones opposite the hypodermal sclerenchymatous strands are smaller than the inner (*Fig.* 15). The cells in the centre disintegrate to form a large air space (*Fig.* 18).

Leaf : The leaf being folded along the midrib appears broadly v-shaped in transverse section (*Fig.* 21). The sheathing leaf base is closed (*Fig.* 20). It is thickest in the middle but gradually thins out towards the fused edges (*Fig.* 7).

In the same species, there is pronounced difference between the epidermis of the lower and upper surfaces of the leaf. The upper epidermal cells are considerably larger than the lower but in the midrib region, it forms an articulation tissue of bulliform cells. Thus they are differentiated protoderm cells on the upper surface of the leaf along the mid-vein. Conical silica crystals or spherical aggregates occur chiefly along the veins. Their bases rest on the inner tangential walls of the epidermal cells (a detailed study is in progress). Sub-epidermal sclerenchymatous strands occur at regular intervals usually on both sides. The epidermal cells above them are correspondingly smaller (*Fig.* 22). The mechanical tissue of the leaf is composed of isolated I-girders. The veins are placed in the bridges, smaller bundles alternating between the larger ones. Two sizes of collateral vascular bundles are seen. The photosynthetic zone instead of being continuous is interrupted by extensions of colourless tissue between the vascular bundles (*Figs.* 8, 23). Thus the green tissues are limited to a sheathing girdle. Each

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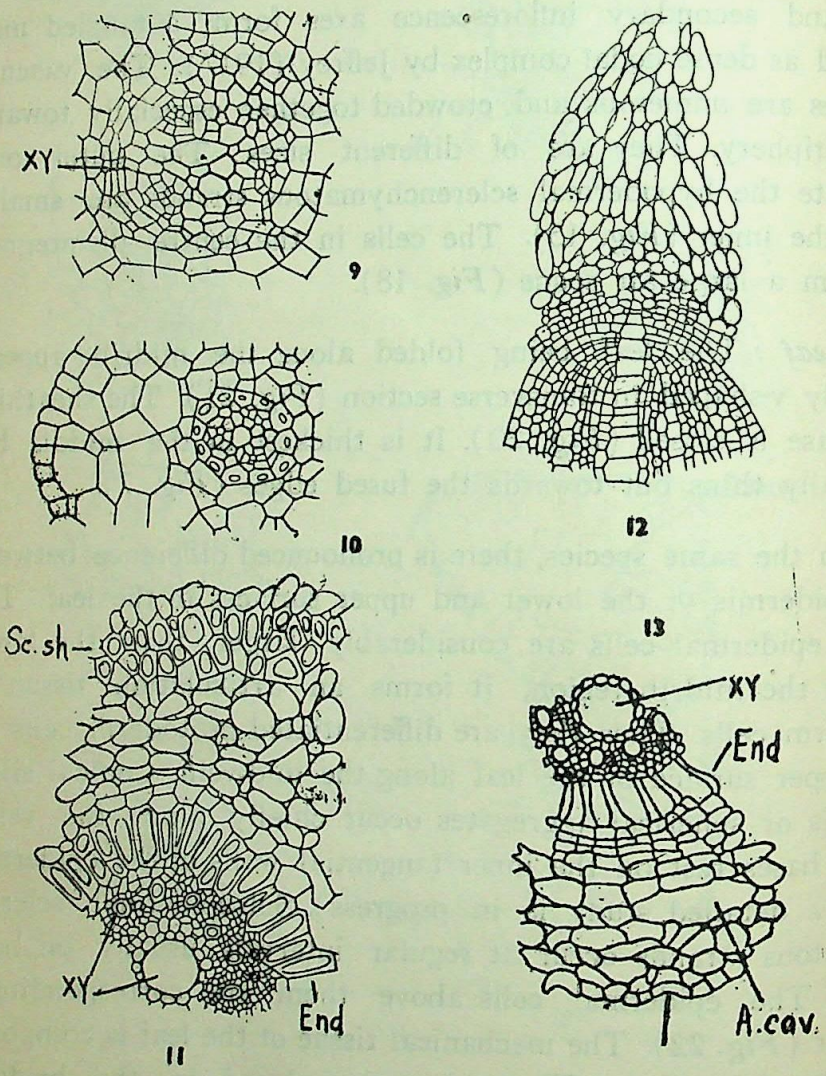

Figs. 9-13 : *Cyperus niveus*, Figs. 9, 10. Triarch stele of the old and young root × 475. Fig. 11. T. s. young adventitious root inside the cortex of the rhizome. Note the thick-walled hypodermis and endodermis × 950. Fig. 12. L. s. root. The central files of cells disintegrate to form a lacuna shown in Fig. 13 × 950.

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vascular bundle is enclosed in a triple ring of cells.

(1) Radiate chlorenchyma
(2) Parenchyma cells with colourless contents
(3) Parenchyma with dense granular contents (*Figs.* 23–24).

Fibrous layers as have been observed by Metcalfe (1964) and Koyama (1965) are absent. Each vascular bundle is surrounded by a sheath of green cells radiating from the centre. The radiate chlorenchyma characterises the tribe Cypereae (Metcalfe, 1964).

Root : The cortex of the young root is composed of parenchymatous cells arranged in radial rows (*Figs.* 4, 12, 25, 56). The primary root is triarch (*Figs.* 9, 10) and dies down when the seedling is 4–5 days old From the tip of the mesocotyl and from the epidermis of the rhizome, several adventitious roots arise (Shah, 1963). The number of protoxylem varies from 16 to 18 in the adventitious roots. Each xylem group consists of a few short, small thin-walled tracheids arranged in a radial plate terminated centrally in a single relatively large vessel. Older roots develop radially arranged air spaces (*Fig.* 13). The gradual change from a thickened endodermal cells forming a protective sheath (*Figs.* 9–11) to a trabecular one (*Fig.* 13) stamp the sedges to thrive in wet as well as dry seasons. The central uniseriate cells break down leaving a large lacuna. The stele has a large central cavity (*Fig.* 27). Pronounced casparian strips have been detected in the thick-walled sheath around the vascular bundles in young and old roots as well as rarely in leaves. An adventitious root reveals a tabular sheath of fibres to resist against radial pressure while it wades its way through the cortex of the rhizome (*Fig.* 11).

Summary

The anatomy of the rachilla, rhizome, root and leaf of *Cyperus niveus* Retz. and *Kyllinga triceps* Rottb. has been studied.

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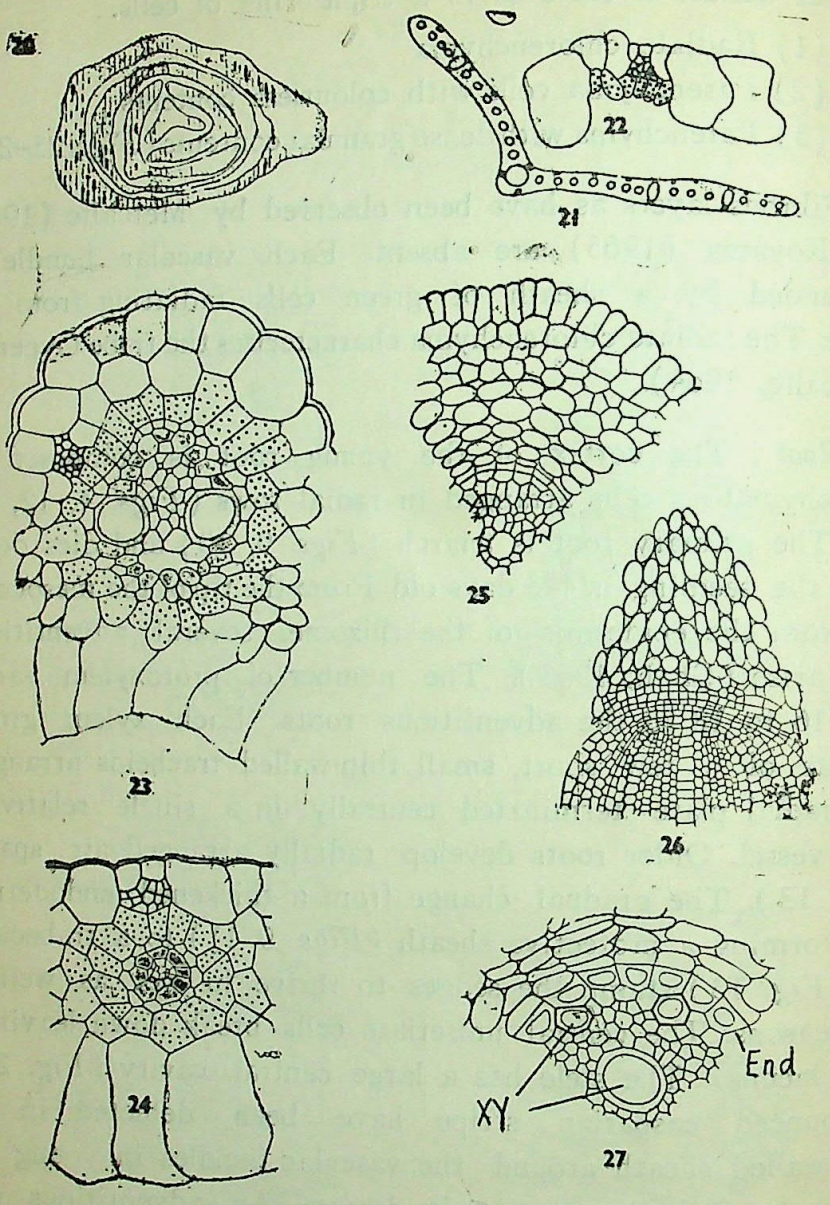

Figs. 20–27 : *Kyllinga triceps*. Fig. 20. T. s. lower portion of the scape surrounded by closed leaf sheaths × 100. diagrammatic. Fig. 21. T. s. leaf, diagrammatic, O-vascular bundles × 100. Fig. 22. Part of the upper epidermis of the leaf × 950. Figs. 23, 24. T. s. through the midrib and the arm of the leaf × 950. Figs. 25, 27. T. s. young and old root × 660. Fig. 26. L. s. root apex × 475.

A cav-air cavity; End-endodermis; l-leaf; Sc. sh-sclerenchymatous sheath; VB-vascular bundle; XY-xylem.

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The cortex of the young root is composed of parenchyma consisting of cells arranged in radial files. The cortical cells break down in the older roots leaving large lacunae tangentially arranged and a stelar central space formed by the disintegration of the metaxylem elements. Underground storage in the rhizome is a response to a resting season which periodically recurs in the life of the plant. The vascular bundles are centrivasal and amphivasal in the rhizome but collateral in the inflorescence axis. In the leaf stomata are not sunken but on the contrary slightly raised. Two sizes of collateral vascular bundles are seen. The upper epidermal cells are larger than the lower. The presence of silica cells in the epidermis characterises the Cyperaceae.

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have a 1 : 1 composition. Solutions of all the three reagents were prepared in 40% ethyl alcohol. Ionic strength was maintained at 0·1μ by adding requisite amount of sodium per chlorate solution. Experiments were carried out at room temperature.

The stability constants of the complexes formed were calculated from the results obtained by—

(1) the mole ratio method
(2) the method of continuous variation

(1) The mole ratio method:

If the dissociation of the complex be represented by the equation

$$M_mA_n = mM + nA$$

c	0	0	initial concentrations
$c(1-\alpha)$	$m\alpha c$	$n\alpha c$	equilibrium concentrations,

the dissociation constant K may be written as

$$K = \frac{(m\alpha c)^m\ (n\alpha c)^n}{c(1-\alpha)} \qquad (1)$$

where c = concentration
α = degree of dissociation of the complex
m and n are integral numbers.

The degree of dissociation α may be calculated by the relation $= \frac{Em - Es}{Em}$ where the terms have the usual significance.

The stability constant k is the reciprocal of the dissociation constant and is obtained by the relation

$$k = \frac{c\,(1-\alpha)}{(m\alpha c)^m\ (n\alpha c)^n} \qquad (3)$$

The stability constant can also be calculated by the relation

$$k = \frac{x}{(a-x)^m\ (b-nx)^n} \qquad (4)$$

where a = concentration of metal ions
b = concentration of the ligand
x = concentration of the complex

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x can be calculated from the observed absorbance at 470 $m\mu$ and the molar abserptivity by the relation

$$\text{concentration} = \text{absorbance} \div \text{molar absorptivity} \qquad (5)$$

The molar absorptivity and the stability constant can also be obtained with the help of the following relation[5], which is valid for 1:1 mole ratio complexes and for the systems in which the absorbance of the uncomplexed metal ions is negligible at the wavelength used

$$A = E_c bc = \frac{E_c\ bk\ (M)\ (R)}{1+K\ (R)} \qquad (6)$$

where

E_c is the molar absorptivity of the complex

c is the concentration of the complex

b is the optical pathlength

M is the molar concentration of Fe

R is the molar concentration of ligand

k is the stability constant.

The relation (6) can be used in the form of the equation

$$\frac{M(b)}{A} = \frac{1}{E_c} + \frac{1}{kE_cR} \qquad (7)$$

Values of $\frac{M(b)}{A}$ and $1/k$ calculated from the data obtained in the mole ratio experiments are plotted against each other. From this graph, E_c and k are calculated respectively from the intercept and the slope.

(2) The method of continuous variation :

The degree of dissociation α is calculated with the help of relation (2), where E_m is the theoretical absorbance calculated from the molecular extinction coefficient and E_s is the observed absorbance. The value of stability constant for $n=1$, $n=2$ and $n=3$ calculated with the help of relation (3).

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(1) Ferric–2, 4 dihydroxyacetophenone complex :

The stability constants calculated with the help of above-mentioned relations 3 and 4 are shown in Tables 1 and 2. The values of k are constant for $n=1$ confirming the formation of a 1:1 complex.

TABLE 1

Stability constants of the ferric DHA complex from the continuous variation data (using equation 3)

($\mu = 0 \cdot 1M$ $NaClO_4$, pH 2·9)

	k ($n=1$)	k ($n=2$)	k ($n=3$)
p=0·5	$0 \cdot 8667 \times 10^3$	$0 \cdot 3985 \times 10^6$	$0 \cdot 1080 \times 10^9$
p=2·0	$0 \cdot 8712 \times 10^3$	$0 \cdot 2541 \times 10^7$	$0 \cdot 1738 \times 10^9$

TABLE 2

Stability constants of ferric DHA complex from the mole ratio data (using equation 4)

($\mu = 0 \cdot 1M$ $NaClO_4$, pH 2·9)

Ratio *Fe/R.*	k $n=1$	k $n=2$	k $n=3$
1:0·2	$0 \cdot 8015 \times 10^3$	$2 \cdot 828 \times 10^7$	$4 \cdot 102 \times 10^{12}$
1:0·4	$0 \cdot 7811 \times 10^3$	$1 \cdot 246 \times 10^7$	$6 \cdot 569 \times 10^{11}$
1:0·6	$0 \cdot 8085 \times 10^3$	$8 \cdot 798 \times 10^6$	$3 \cdot 137 \times 10^{11}$
1:0·8	$0 \cdot 8041 \times 10^3$	$5 \cdot 932 \times 10^6$	$1 \cdot 251 \times 10^{11}$
1:1·0	$0 \cdot 8441 \times 10^3$	$4 \cdot 971 \times 10^6$	$8 \cdot 307 \times 10^{10}$
1:1·5	$0 \cdot 8149 \times 10^3$	$2 \cdot 852 \times 10^6$	$2 \cdot 190 \times 10^{10}$
1:2·0	$0 \cdot 7894 \times 10^3$	$1 \cdot 895 \times 10^6$	$7 \cdot 167 \times 10^9$
1:4·0	$0 \cdot 7837 \times 10^3$	$7 \cdot 7791 \times 10^5$	$1 \cdot 180 \times 10^9$

The stability constant was also determined graphically using equation 7. Results are plotted in Figure 1. From this

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graph, the values of E_c and k are $21 \cdot 07 \times 10^2$ and $0 \cdot 6156 \times 10^3$ respectively.

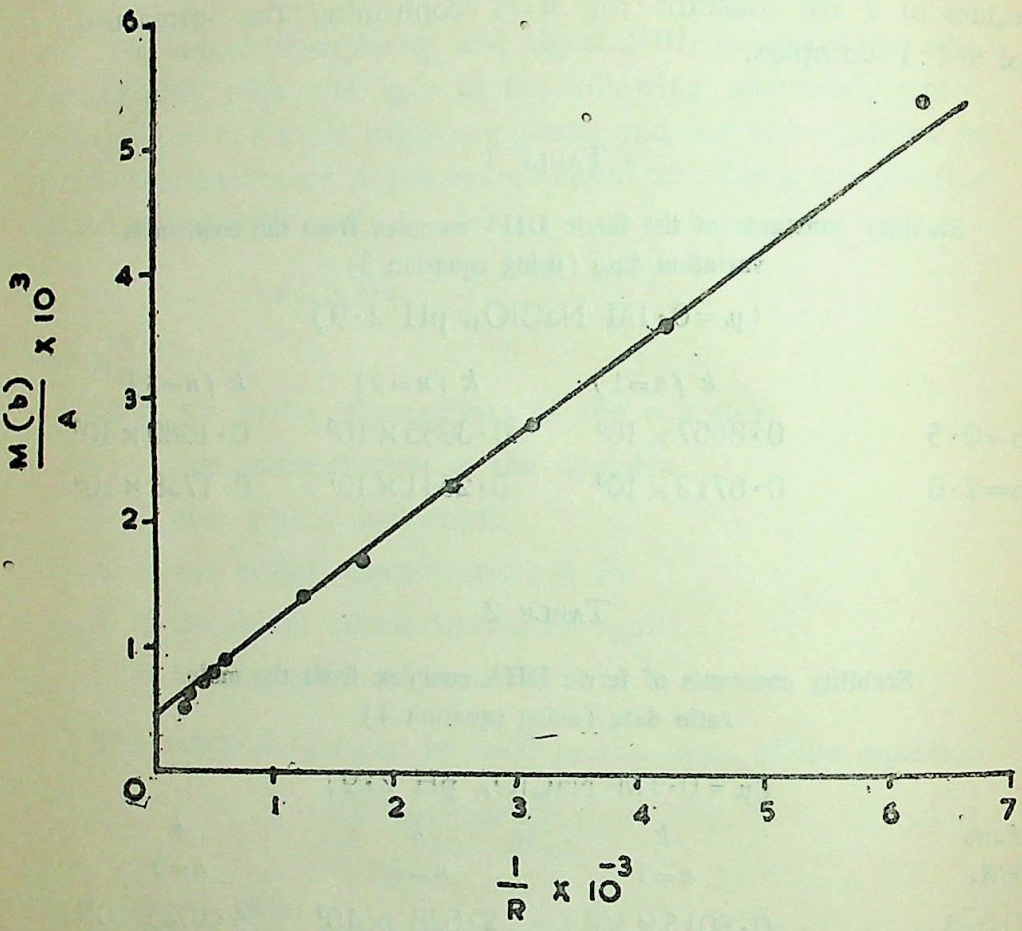

Fig. 1 : Determination of molar absorptivity and stability constant of ferric DHA complex

(2) Ferric–2, 4 dihydroxypropiophenone complex :

The values of stability constants calculated from the continuous variation and the mole ratio data are given in tables 3 and 4. From this tables, it will be seen that the values are fairly constant for $n=1$, which confirms the formation of a 1 : 1 complex.

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TABLE 3

Stability constants of the ferric DHP complex from the continuous variation data (using equation 3)

($\mu = 0 \cdot 1M$ $NaClO_4$, pH 2·9)

	$k(n=1)$	$k(n=2)$	$k(n=3)$
p=0·5	$1 \cdot 589 \times 10^{3}$	$2 \cdot 019 \times 10^{8}$	$9 \cdot 862 \times 10^{10}$
p=2·0	$1 \cdot 161 \times 10^{3}$	$3 \cdot 546 \times 10^{7}$	$6 \cdot 411 \times 10^{11}$

TABLE 4

Stability constants of the ferric DHP complex from the mole ratio data (using equation 4)

($\mu = 0 \cdot 1M$ $NaClO_4$, pH 2·9)

Ratio Fe/R.	k $n=1$	k $n=2$	k $n=3$
1:0·4	$1 \cdot 244 \times 10^{3}$	$3 \cdot 514 \times 10^{9}$	$4 \cdot 887 \times 10^{13}$
1:0·6	$1 \cdot 238 \times 10^{3}$	$2 \cdot 823 \times 10^{7}$	$1 \cdot 103 \times 10^{13}$
1:0·8	$1 \cdot 294 \times 10^{3}$	$1 \cdot 574 \times 10^{7}$	$3 \cdot 138 \times 10^{13}$
1:1·0	$1 \cdot 340 \times 10^{3}$	$7 \cdot 771 \times 10^{6}$	$1 \cdot 376 \times 10^{12}$
1:1·5	$1 \cdot 264 \times 10^{3}$	$6 \cdot 042 \times 10^{6}$	$1 \cdot 369 \times 10^{11}$
1:2·0	$1 \cdot 086 \times 10^{3}$	$2 \cdot 982 \times 10^{6}$	$2 \cdot 167 \times 10^{10}$
1:4·0	$1 \cdot 205 \times 10^{3}$	$1 \cdot 336 \times 10^{6}$	$2 \cdot 531 \times 10^{9}$

Figure 2 shows a graphical determination of the stability constant. From this graph, the values of E_c and K are respectively $13 \cdot 79 \times 10^{2}$ and $0 \cdot 967 \times 10^{3}$.

(3) Ferric–2, 4 dihydroxybutyrophenone complex :

Stability constants of the complex were calculated and are shown in Tables 5 and 6. The small spread of K values for $n=1$ confirms the formation of a 1:1 complex.

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TABLE 5

Stability constants of the ferric DHB complex from the continuous variation data (using equation 3)

($\mu = 0 \cdot 1M$ $NaClO_4$, pH = 2·9)

	$k(n=1)$	$k(n=2)$	$k(n=3)$
p = 0·5	$0 \cdot 6795 \times 10^3$	$0 \cdot 3023 \times 10^6$	$0 \cdot 7609 \times 10^8$
p = 2·0	$0 \cdot 6564 \times 10^3$	$0 \cdot 1709 \times 10^6$	$0 \cdot 2597 \times 10^8$

TABLE 6

Stability constants of the ferric DHB complex from the mole ratio data (using equation 4)

($\mu = 0 \cdot 1M$ $NaClO_4$, pH = 2·9)

Ratio Fe/R.	$k(n=1)$	$k(n=2)$	$k(n=3)$
1 : 0·2	$0 \cdot 7391 \times 10^3$	$2 \cdot 301 \times 10^7$	$2 \cdot 307 \times 10^{12}$
1 : 0·4	$0 \cdot 6778 \times 10^3$	$9 \cdot 381 \times 10^6$	$3 \cdot 278 \times 10^{11}$
1 : 0·6	$0 \cdot 6797 \times 10^3$	$6 \cdot 087 \times 10^6$	$1 \cdot 296 \times 10^{11}$
1 : 0·8	$0 \cdot 6522 \times 10^3$	$4 \cdot 145 \times 10^6$	$5 \cdot 585 \times 10^{10}$
1 : 1·0	$0 \cdot 6798 \times 10^3$	$3 \cdot 434 \times 10^6$	$3 \cdot 709 \times 10^{10}$
1 : 1·5	$0 \cdot 7082 \times 10^3$	$2 \cdot 295 \times 10^6$	$1 \cdot 485 \times 10^{10}$
1 : 2·0	$0 \cdot 6977 \times 10^3$	$1 \cdot 581 \times 10^6$	$6 \cdot 476 \times 10^9$
1 : 4·0	$0 \cdot 7925 \times 10^3$	$7 \cdot 482 \times 10^5$	$1 \cdot 111 \times 10^9$

The stability constant was determined graphically with the help of equation 7. The results are shown in Figure 3. From this graph, the values of E_c and K are respectively $12 \cdot 50 \times 10^2$ and $0 \cdot 6001 \times 10^3$.

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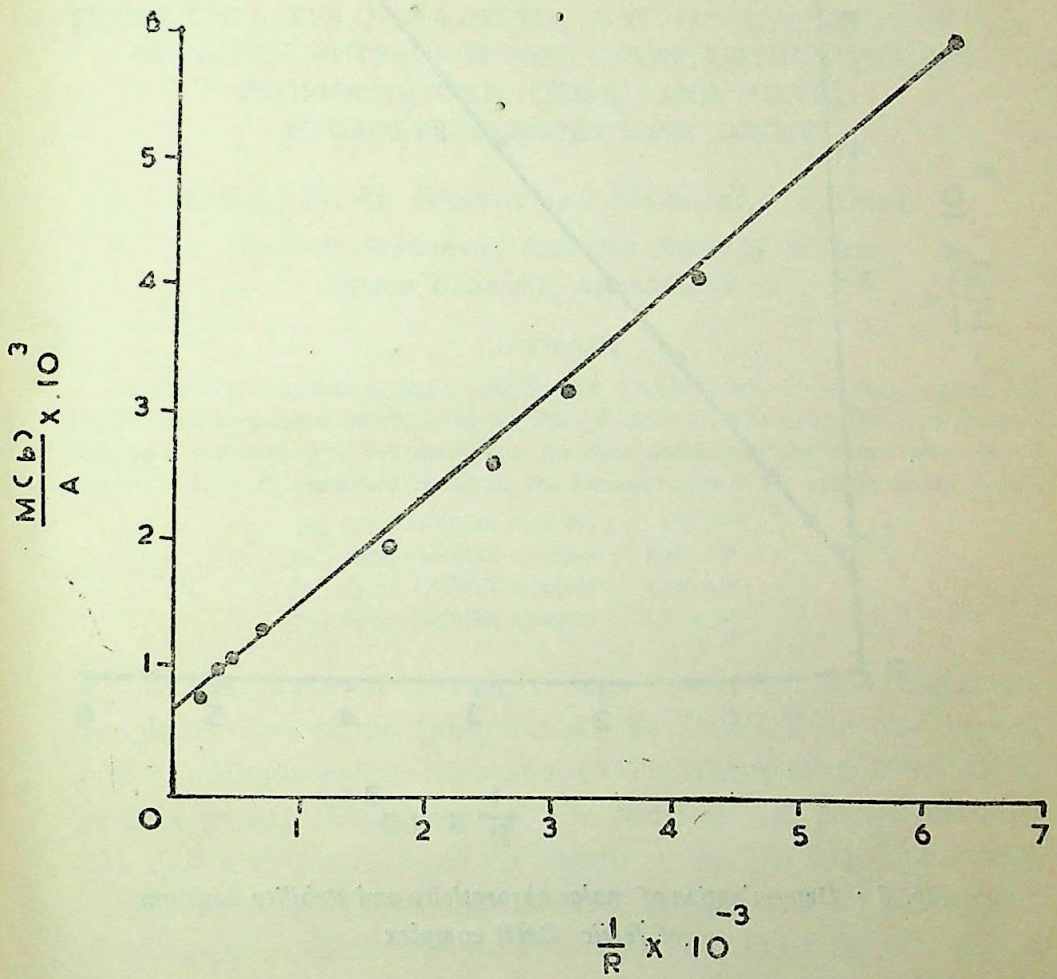

Fig 2 : Determination of the molar absorptivity and stability constant of ferric DHP complex.

It will be observed that the values of stability constants calculated by different methods show a fairly good agreement.

We thank Dr. B. K. Vaidya for his kind interest and the Ministry of Education, Government of India for the award of a research fellowship to one of us, Miss M. H. Gandhi.

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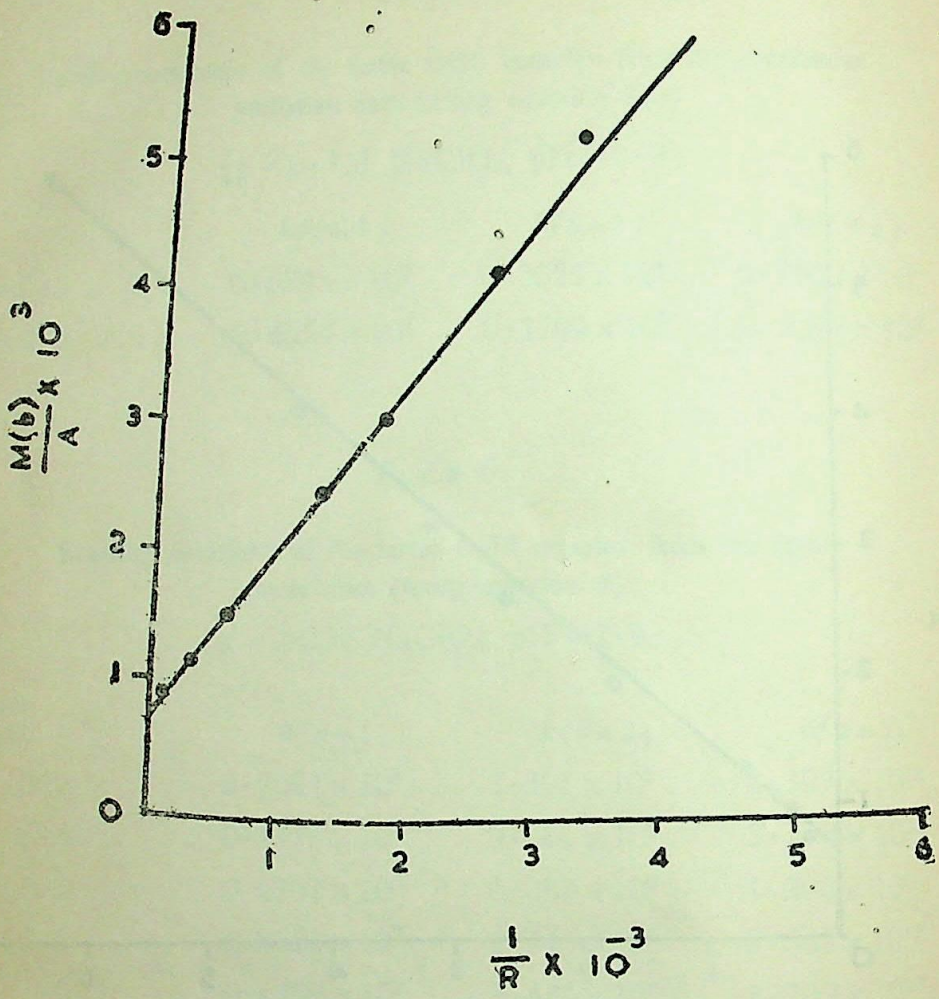

Fig. 3 : Determination of molar absorptivity and stability constant of ferric DHB complex

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SPECTROPHOTOMETRIC EVALUATION OF STABILITY CONSTANTS-II FERRIC CHELATES OF 2, 4 DIHYDROXYPROPHENONE OXIME, 2, 4 DIHYDROXYBUTYROPHENONE OXIME, ORTHO HYDROXY-PROPIOPHENONE, OXIME AND ORTHO HYDROXYBUTYROPHENONE OXIME

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ABSTRACT

The stability constants of ferric chelates with 2, 4 dihydroxypropiophenone oxime, 2, 4 dihydroxybutyrophenone oxime, ortho hydropropiophenone oxime and orthohydroxybutyrophenone oxime have been calculated from the data obtained by the mole ratio method and the method of continuous variation. The average values of the stability constants are :

(*i*) ferric DHPOX complex : 1.43×10^{-8}
(*ii*) ferric DHBOX complex : 1.10×10^{8}
(*iii*) ferric OHPOX complex : 1.56×10^{8}
(*iv*) ferric OHBOX complex : 1.13×10^{8}

It was observed that ferric ions react with 2, 4 dihydroxy propiophenone oxime (abbreviated as DHPOX in this paper) and 2, 4 dihydroxybutyrophenone oxime (abbreviated as DHBOX in this paper). The colour of the complex was purple between pH 2·0 and pH 3·0 and red brown above 3·0 pH. The purple coloured complexes between pH 2·0 and pH 3·0 are stable and show a maximum absorbance at 510 $m\mu$. The optimum pH range is 2·6 to 2·8. The ferric complexes of ortho hydroxypropiophenone oxime (OHPOX) and orthohydroxy butyrophenone oxime (OHBOX) were red between pH 2·0 and pH 3·0 and brown above pH 3·0, the former being stable. These complexes show a general absorption of light. The optimum pH range for complex formation is 2·9 to 3·0.

A study of the composition of the complexes by the mole ratio method[1], the method of continuous variation[2], the slope ratio method[3] and the Bent and French method[4] indicated that all these complexes have a 1 : 1 composition. The stability

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constants were calculated by the relations given in our previous communication (Part I, page 240 of this Journal).

(1) Ferric-2, 4 dihydroxypropiophenone oxime complex :

The stability constants obtained from various equations are given in tables 1 and 2. The small spread of k values for $n=1$ confirms the formation of a 1 : 1 complex.

TABLE I

Stability constants of the ferric DHPOX complex from the continuous variation data (using equation 3)

($\mu=0\cdot1$M $NaClO_4$, pH 2·7)

	k ($n=1$)	k ($n=2$)	k ($n=3$)
p=0·5	$1\cdot572\times10^{3}$	$1\cdot413\times10^{7}$	$7\cdot521\times10^{8}$
p=2·0	$1\cdot653\times10^{3}$	$9\cdot280\times10^{5}$	$2\cdot961\times10^{8}$

TABLE II

Stability constants of the ferric DHPOX complex from mole ratio data (using equation 4)

($\mu=0\cdot1$M $NaClO_4$, pH 2·7)

Ratio Fe/R.	k ($n=1$)	k ($n=2$)	k ($n=3$)
1 : 0·2	$1\cdot882\times10^{3}$	$2\cdot793\times10^{9}$	$2\cdot195\times10^{10}$
1 : 0·4	$1\cdot533\times10^{3}$	$6\cdot600\times10^{7}$	$1\cdot933\times10^{11}$
1 : 0·6	$1\cdot429\times10^{3}$	$2\cdot653\times10^{7}$	$5\cdot551\times10^{13}$
1 : 0·8	$1\cdot406\times10^{3}$	$1\cdot636\times10^{7}$	$3\cdot746\times10^{12}$
1 : 1·0	$1\cdot475\times10^{3}$	$1\cdot533\times10^{7}$	$3\cdot962\times10^{12}$
1 : 1·5	$1\cdot216\times10^{3}$	$5\cdot319\times10^{6}$	$9\cdot519\times10^{10}$
1 : 2·0	$1\cdot186\times10^{3}$	$3\cdot227\times10^{6}$	$2\cdot555\times10^{10}$

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The stability constant was also determined graphically. Results are shown in figure 1. From this graph, the values of E and k are respectively $21 \cdot 54 \times 10^2$ and $0 \cdot 9914 \times 10^3$.

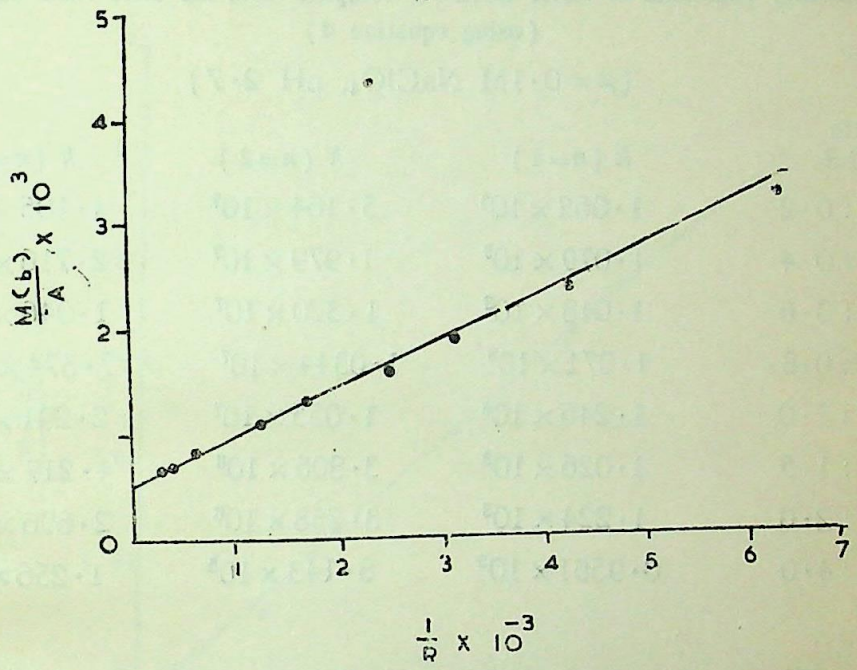

Fig. 1 : Determination of molar absorptivity and stability constant of ferric DHPOX complex

(2) Ferric-2, 4 dihydroxybutyrophenone oxime complex :

The stability constant calculated with the help of various relations are shown in tables 3 and 4. The values are constant for $n=1$ confirming the formation of a 1 : 1 complex.

TABLE III

Stability constants of the ferric DHBOX complex from the continuous variation data (using equation 3)

($\mu = 0 \cdot 1$M $NaClO_4$, pH 2·7)

	k ($n=1$)	k ($n=2$)	k ($n=3$)
p=0·5	$1 \cdot 540 \times 10^3$	$1 \cdot 102 \times 10^6$	$3 \cdot 749 \times 10^8$
p=2·0	$1 \cdot 118 \times 10^3$	$3 \cdot 3366 \times 10^5$	$6 \cdot 007 \times 10^7$

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Table IV

Stability constants of ferric DHBOX complex from the mole ratio data (using equation 4)

($\mu = 0 \cdot 1$M $NaClO_4$, pH 2·7)

Ratio Fe/R.	k ($n=1$)	k ($n=2$)	k ($n=3$)
1 : 0·2	$1 \cdot 062 \times 10^3$	$5 \cdot 164 \times 10^7$	$4 \cdot 105 \times 10^{13}$
1 : 0·4	$1 \cdot 079 \times 10^3$	$1 \cdot 979 \times 10^7$	$2 \cdot 716 \times 10^{12}$
1 : 0·6	$1 \cdot 018 \times 10^3$	$1 \cdot 320 \times 10^7$	$1 \cdot 046 \times 10^{12}$
1 : 0·8	$1 \cdot 071 \times 10^3$	$1 \cdot 0344 \times 10^7$	$7 \cdot 374 \times 10^{11}$
1 : 1·0	$1 \cdot 246 \times 10^3$	$1 \cdot 055 \times 10^7$	$2 \cdot 291 \times 10^{11}$
1 : 1·5	$1 \cdot 026 \times 10^3$	$3 \cdot 806 \times 10^6$	$4 \cdot 217 \times 10^{10}$
1 : 2·0	$1 \cdot 224 \times 10^3$	$3 \cdot 258 \times 10^6$	$2 \cdot 606 \times 10^{10}$
1 : 4·0	$0 \cdot 9561 \times 10^2$	$8 \cdot 143 \times 10^5$	$1 \cdot 256 \times 10^9$

The molar absorptivity and the stability constant were determined graphically. Results are shown in figure 2. From this graph, the values of E_c and k are respectively $15 \cdot 38 \times 10^2$ and $0 \cdot 7029 \times 10^3$.

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(3) Ferric orthohydroxypropiophenone oxime complex :

The stability constants obtained from various equations are given in tables 5 and 6. Values of k for $n=1$ are constant confirming the formation of a 1:1 complex.

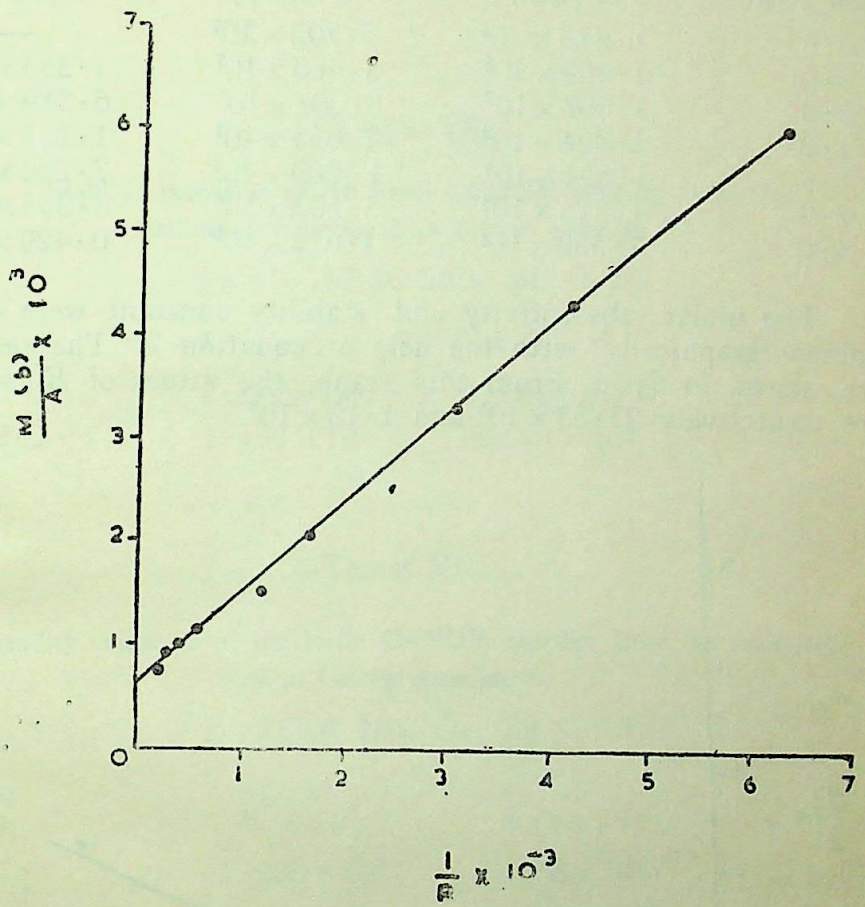

Fig 2 : Determination of the molar absorptivity and stability constant of ferric DHBOX complex

TABLE V

Stability constants of the ferric OHPOX complex from the continuous variation data (using equation 3)

($\mu=0\cdot1$M $NaClO_4$, pH 2·9)

	k ($n=1$)	k ($n=2$)	k ($n=3$)
p=0·5	$1\cdot708\times10^3$	$1\cdot565\times10^6$	$8\cdot493\times10^8$
p=2·0	$1\cdot456\times10^3$	$7\cdot684\times10^6$	$2\cdot404\times10^8$

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TABLE VI

Stability constants of ferric OHPOX complex from the mole ratio data (using equation 4)

($\mu = 0 \cdot 1$M $NaClO_4$, pH 2·9)

Ratio Fe/R.	k ($n=1$)	k ($n=2$)	k ($n=3$)
1:0·4	$1 \cdot 473 \times 10^3$	$5 \cdot 792 \times 10^7$	—
1:0·6	$1 \cdot 499 \times 10^3$	$3 \cdot 460 \times 10^7$	$1 \cdot 353 \times 10^{15}$
1:0·8	$1 \cdot 667 \times 10^3$	$3 \cdot 001 \times 10^7$	$6 \cdot 519 \times 10^{15}$
1:1·0	$1 \cdot 804 \times 10^3$	$2 \cdot 655 \times 10^7$	$1 \cdot 107 \times 10^{14}$
1:1·5	$1 \cdot 651 \times 10^3$	$1 \cdot 009 \times 10^7$	$7 \cdot 236 \times 10^{11}$
1:2·0	$1 \cdot 513 \times 10^3$	$5 \cdot 303 \times 10^6$	$8 \cdot 095 \times 10^{10}$
1:4·0	$1 \cdot 330 \times 10^3$	$1 \cdot 612 \times 10^6$	$0 \cdot 429 \times 10^9$

The molar absorptivity and stability constant were determined graphically with the help of equation 7. The results are shown in fig. 3. From this graph, the values of E_c and k are respectively $23 \cdot 53 \times 10^2$ and $1 \cdot 10 \times 10^3$.

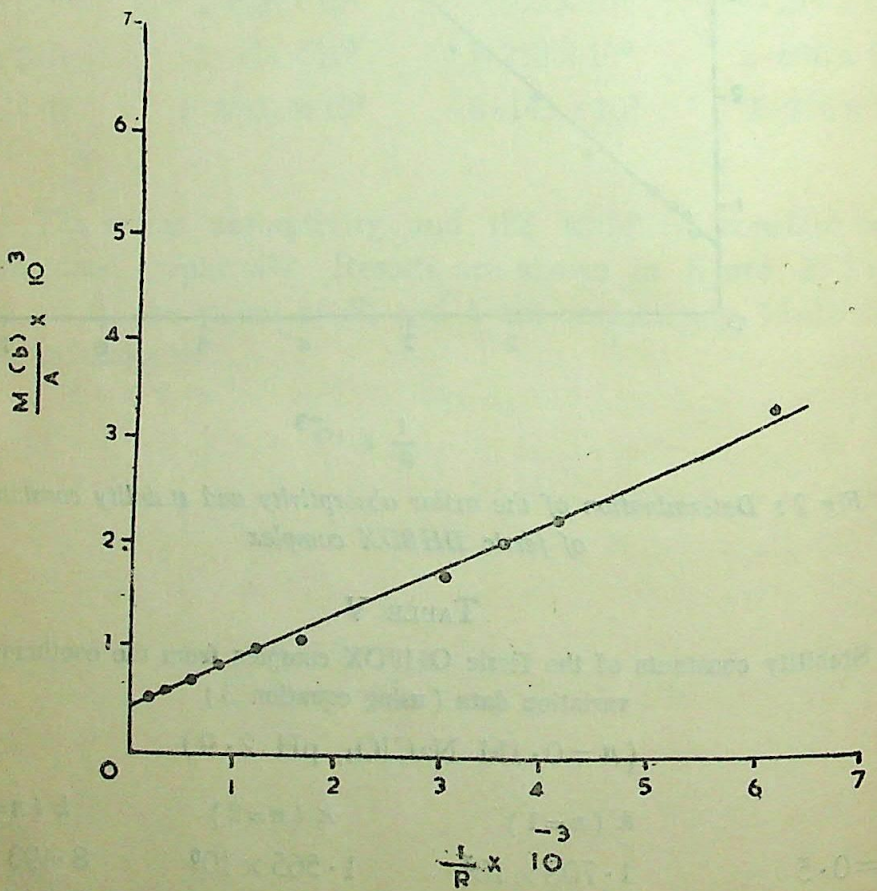

Fig. 3 : Determination of molar absorptivity and stability constant of ferric OHPOX complex

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(4) Ferric orthohydroxybutyrophenone oxime comlex:

The stability constants calculated with the help of various relations are given in tables 7 and 8. The small spread of k values from $n=1$ confirms the formation of a 1:1 complex.

TABLE VII

Stability constants of the ferric OHBOX complex from the continuous variation data (using equation 3)

($\mu=0\cdot1M$ $NaClO_4$, pH 2·9)

	k ($n=1$)	k ($n=2$)	k ($n=3$)
p=0·5	$1\cdot249\times10^{3}$	$1\cdot066\times10^{6}$	$5\cdot395\times10^{8}$
p=2·0	$1\cdot194\times10^{2}$	$5\cdot961\times10^{5}$	$1\cdot764\times10^{8}$

TABLE VIII

Stability constants of the ferric OHBOX complex from the mole ratio data (using equation 4)

($\mu=0\cdot1M$ $NaClO_4$, pH 2·9)

Ratio Fe/R.	k ($n=1$)	k ($n=2$)	k ($n=3$)
1:0·4	$1\cdot006\times10^{3}$	$1\cdot368\times10^{7}$	$8\cdot511\times10^{11}$
1:0·6	$1\cdot099\times10^{3}$	$0\cdot8381\times10^{7}$	$1\cdot129\times10^{11}$
1:0·8	$1\cdot072\times10^{3}$	$1\cdot036\times10^{7}$	$4\cdot717\times10^{10}$
1:1·0	$1\cdot140\times10^{3}$	$0\cdot8764\times10^{7}$	$3\cdot095\times10^{11}$
1:1·5	$1\cdot097\times10^{3}$	$0\cdot4688\times10^{7}$	$6\cdot908\times10^{10}$
1:2	$1\cdot105\times10^{3}$	$0\cdot3178\times10^{7}$	$2\cdot474\times10^{10}$
1:4	$1\cdot298\times10^{3}$	$0\cdot1396\times10^{3}$	$2\cdot766\times10^{9}$

The stability constant of the complex was determined graphically with the help of equation 7. The results are given in figure 4. From this graph, the values of E_c and k are respectively $20\cdot00\times10^{2}$ and $0\cdot8002\times10^{3}$.

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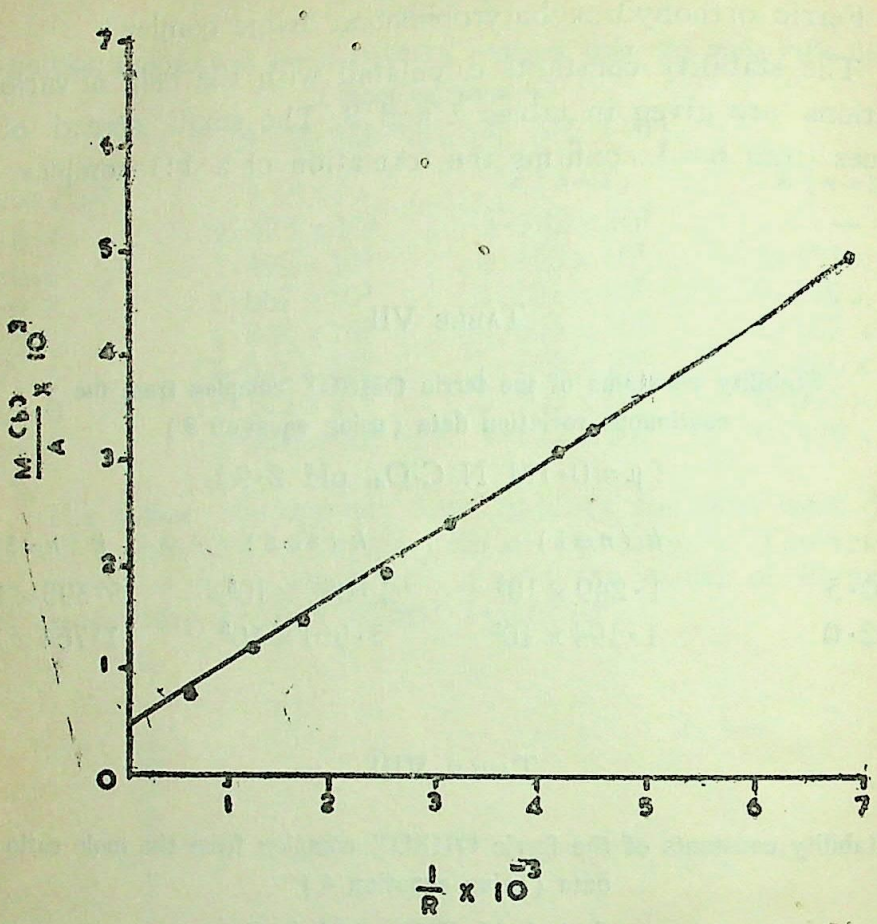

Fig. 4 : Determination of molar absorptivity and stability constant of ferric OHBOX complex

It will be observed that the values of the stability constants calculated by various methods show a fairly good agreement.

We thank Professor B. K. Vaidya for his kind interest and the Ministry of Education, Government of India, for the award of a research training scholarship to one of us, Miss M. H. Gandhi.

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ADDITIONS TO THE FLORA OF PAVAGADH HILL IN EASTERN GUJARAT

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Introduction

Pavagadh hill is situated 73° × 29′ and 73° × 33′ *E* and 22° × 26′ and 22° × 30′ N, about 46·4 kms. from Baroda. Its flora has now been fairly known through the works of Chavan and Oza (1962, 1966) and Shah and Inamdar (1965). During botanical excursions to this area in September 1964 and in August, March and April 1965 and 1966, the authors collected a number of plants, a few of which, so far, have not been reported by earlier workers. They are, therefore, recorded here with a view to add information towards the completion of the flora of Pavagadh. For each plant, a short description, its ecology, distribution in the State, collector's number, etc. are given.

Enumeration of Plants

Capparidaceae

Cleome chelidonii L.f.

Erect herbs, 45–75 cm. tall. Flowers rosy pink.

Common in moist ground along margins of a pond on way to Machi, growing with *Cyperus iria* Linn., *Cyperus triceps* End–l., *Eclipta prostrata* Linn., *Heliotropium ovalifolium* Forsk., *Indigofera glandulosa* Willd., etc. (*Shah* 11739). There are two types of leaves, radical and cauline, the former forming an elegant rosette on the ground. Cooke (1958) does not mention the radical leaves.

Distribution in Gujarat : Saurashtra, Pavagadh and Dang's forest.

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Burseraceae

Boswellia serrata Roxb. ex Colebr.

A medium sized deciduous tree with white or ash coloured bark. Drupes trigonous with heart shaped pyrenes.

Rare, in the forest near Machi. Collected in fruits in the month of March and April (*Shah* 11700-A).

Distribution in Gujarat : Saurashtra, Modasa in North Gujarat, Pavagadh and Dang's forest.

Sapindaceae

Schleichera oleosa (Lour.) Oken

Schleichera trijuga Willd.; Cooke Fl. Pres. Bombay, 1:283, 1958 (reprinted).

Trees 8–10 m. tall. Flowers greenish-yellow.

Rare, in the forest near Machi. Collected in flowers in April 1966. This is one of the conspicuous trees in the forest by the overall reddish-purple colour of the fresh leaves (*Shah* 11741).

Distribution in Gujarat: Saurashtra (Gir forest), Pavagadh and Dang's forest.

Liliaceae

Iphigenia indica (L.) Gray.

Perennial herbs, erect, simple or sparingly branched, grass like, 15–30 cm tall. Flowers 10–12 mm. across, deep violet purple, solitary and terminal. Perianth star-shaped. Capsule 15–20 × 5–8 mm, ellipsoid-oblong, glabrous.

Rare among grasses on hilly slopes on way to the place of origin of river Vishwamitri. This is a typical monsoon plant appearing after a first few showers; later it is concealed among tall grasses and is often overlooked.

Distribution in Gujarat : At present only Pavagadh.

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Cyperaceae

Bulbostylis barbata (Rottb.) Kunth.

Stenophyllus barbatus Rottb.: Cooke, Fl. Pres. Bombay 3:401, 1958 (reprinted).

Slender herbs, 10–15 cm. tall. Spikelets brown.

Occasional among grasses with *Cleome chelidoni*, L.f. (*Patel* without number).

Distribution in Gujarat: According to Sabnis (1962), the plant is distributed throughout the plains and hilly regions of Gujarat but abundant in North and Central Gujarat.

Summary

A short taxonomical account of a few plants, which so far have not been listed from Pavagadh, is given here.

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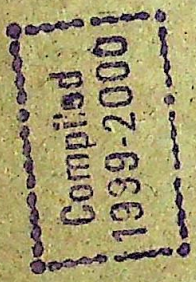

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